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PHILIPPINE ERICACEÆ, I: THE SPECIES OF RHODODENDRON

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SIXTEEN PLATES

INTRODUCTION

The Philippine species of the large, widespread, and polymorphous genus *Rhododendron* are almost entirely confined to the mossy forest on ridges leading up to mountain peaks and on the peaks themselves. The mossy forest is an environment of high humidity, low illumination, and moderate temperature; the vegetation thrives under conditions of intense competition for space and light.

In isolation, here furnished by mountain tops, and under the pressure of competition, organisms show markedly a tendency to produce series of distinct forms, which, by some authors, are described as species. In the present genus this is particularly noticeable in *Rhododendron quadrasianum* and *R. vidalii* and in the circle of relationship of *R. clementis*.

The environment of the tropical mossy forest induces many plants to live as epiphytes. Thus most of the species in the group under discussion occur as epiphytes, but they are also capable of terrestrial life wherever they find space; some of them reach the size of small trees.

The flowers of several species are large, brightly colored, and extremely attractive. It was the hope of Stein, expressed in his description of *R. apoanum* and *R. kochii*, that both might

speedily be brought into cultivation. As far as is known, this has never been accomplished, either for these species or for any others occurring in the Philippines. Several related species from the Malay Peninsula and Archipelago are described in Curtis's Botanical Magazine as in cultivation under glass in England fifty or more years ago, and doubtless most or all of the Philippine species could thus be grown.

The mountain flora was unknown to Blanco and his predecessors. No Philippine *Rhododendron* was named before 1883, although at least four collections had been made. *Cuming 804,* collected on Mount Banahao in 1839, represents a form of *R. quadrasianum;* the exploration of Mount Banahao by Vidal yielded one more, which he identified as *R. javanicum,* but which we now know represents *R. kochii.* The ascent of Mount Apo by Koch and Schadenberg, in 1882, yielded two species that were incorrectly identified by Fernandez-Villar, in 1883, as *R. javanicum* and *R. jasminiflorum.* Stein named them respectively *R. apoanum* and *R. kochii,* apparently in Verhandlungen der schlesischen Gesellschaft für vaterländische Cultur for 1883; I have not seen this publication. In 1885 he gave full descriptions of both species in Gartenflora, with illustrations.

In 1886 Vidal, the ablest Spanish botanist in the Philippines, listed six species in his Revision de Plantas Vasculares Filipinas: *R. javanicum, R. kochii, R. apoanum,* and three new species, *R. quadrasianum, R. rosmarinifolium,* and *R. verticillatum.* In the following year Rolfe changed the name of the last species to *R. vidallii* (*R. verticillatum* Vidal, nom Low). Another I have here reduced. Vidal remains the authority for the name of the commonest Philippine species, *R. quadrasianum.*

The collections made by John Whitehead in 1896 were studied at the British Museum, and A. B. Rendle described *R. subsessile, R. whiteheadi,* and *R. lussoniense* as new; the last, however, is identical with *R. vidalii.* He also identified a specimen from Mount Halcon as *R. cuneifolium* Stapf, which was correct in the sense that in my opinion *R. cuneifolium* is indistinguishable as a species from *R. quadrasianum.*

Soon after the American occupation of the Islands, J. Perkins began to study the Philippine material in European herbaria, particularly in Berlin. In connection with her work, Warburg described the rare *R. schadenbergii* in 1905.

In the same year, in his third paper on new or noteworthy Philippine plants, Merrill enumerated the fourteen known spe-

cies, including the new *R. xanthopetalum, R. mindanaense, R. spectabile,* and *R. copelandi,* the first from the collections of Whitford on Mount Mariveles, the other three from the collections of Copeland on Mount Apo. He added *R. nortoniae* in 1906 and *R. clementis, R. curranii,* and *R. malindangense* in 1908; in the latter year he again reviewed the whole group and listed sixteen species. In 1925 he added *R. leytense,* and in 1926 the very distinct *R. taxifolium.*

Elmer's numerous and valuable collections have yielded no new species except *R. williamsii,* belatedly described below. His paper on the Ericaceæ of Mount Apo, published in 1910 in Leaflets of Philippine Botany, is valuable for the descriptions of plants in the field.

Millais's Rhododendrons, 1917 and 1924, was written from a horticultural point of view. The Philippine species are enumerated with little comment.

The *monograph of Azaleas,* by Wilson and Rehder, 1921, includes a discussion of the relationships of *R. subsessile,* the only Philippine representative of the group.

In the present paper three Philippine species are reduced and *R. cuneifolium* Stapf, of Mount Kina-Balu, in British North Borneo, is identified with *R. quadrasianum.* Five species are published for the first time, making a total of twenty-one. It is confidently expected, however, that further exploration will yield others.

For the present study I have had the use of the collections, Philippine and Indo-Malayan, in the herbarium of the Philippine Bureau of Science, the United States National Herbarium, and the herbarium of the University of California. In the lists of specimens given under each species, I have designated these herbaria, respectively, by the letters M, W, and C. It has been my task to review critically the definitions of the species and the identifications of all the specimens; and, this being completed, to attempt to determine the relationships of the Philippine species, both among themselves and with those of neighboring lands.

Rhododendron subsessile, in contrast to all the other species, is of northern ancestry and finds its nearest relatives in Formosa; it is the sole representative of its section in the Malayan region. The others find their closest relatives in Borneo, with allied species in Java, Sumatra, and New Guinea; it is probable that their ancestors came from India through the Malay Penin-

sula. Only one species is known to extend outside the Philippines, but as Borneo, Celebes, New Guinea, and Sumatra, as well as Mindanao and Palawan in the Philippine group, remain imperfectly explored, it is likely that the list will be increased as exploration progresses.

I have divided the section *Vireya*, to which most of the species belong, into subsections. In part this classification is tentative, but with possible modifications it is expected to prove useful throughout the Malay region.

The work has been carried out at the University of California, Berkeley, under the direction of Dean E. D. Merrill, to whom it is a pleasure to acknowledge a very comprehensive indebtedness.

Natural arrangement of the Philippine rhododendrons.

Subgenus *Eurhododendron* Endlicher.

[Section 1. *Leiorhodion* Rehder. Leaves glabrous. Not represented.]

Section 2. *Lepipherum* G. Don. Leaves more or less densely lepidote; ovary densely lepidote; margins of the bud-scales white-ciliate.

A. Leaves moderately lepidote beneath ..... 1. *R. quadrasianum.*

B. Leaves densely lepidote beneath.

1. Leaves elliptic; filaments glabrous..... 2. R. *apoanum.*
2. Leaves narrow-lanceolate, 9 to 15 cm long; filaments pubescent ..... 3. *R. nortoniae.*
3. Leaves narrow-lanceolate, 5 to 10 cm long; filaments unknown. 4. *R. catanduanense.*

Section 3. *Vireya* Blume as genus. Leaves moderately lepidote; ovary pubescent, glabrous, or moderately lepidote. Bud-scales not white-ciliate except sometimes in subsection 1.

Subsection 1. *Malesia.* Ovary pubescent, filaments glabrous. A single species ..... 5. *R. bagobonum.*

In the following subsections the filaments are pubescent; or, if they are glabrous, the ovary is without hairs.

Subsection 2. *Linearanthera.* Bud-scales acute or acuminate, with brown-fimbriate margins; corolla hairy within, hairy or lepidote without; ovary and filaments pubescent; anthers linear.

A. Leaves orbicular to narrowly elliptic.

1. Flowers white .....6. *R. vidalii.*
2. Flowers red .....7. *R. whiteheadi.*

B. Leaves linear .....8. *R. taxifolium.*

In the following subsections the bud-scales are rounded, with entire margins.

Subsection 3. *Solenovireya.* Bud-scales about 1 cm long; corolla narrowly tubular, usually lepidote without; filaments filiform, pubescent; ovary lepidote to pubescent, style filiform. A single species.....9. *R. copelandi.*

In the following subsections the bud-scales are larger; the corolla is funnelform or obconical, usually hairy within and glabrous without.

Subsection 4. *Euvireya.* Leaves herbaceous; filaments and ovary with or without hairs, in the Philippine species alike; anthers obovoid, often with minute appendages at the base.

A. Flowers white.

1. Leaves rounded; corolla lepidote without; anthers appendaged ..... 12. *R. mindanaense.*
2. Leaves acuminate; corolla glabrous without; anthers not appendaged.
   a. Filaments and ovary pubescent..... 10. *R. kochii.*
   b. Filaments and ovary glabrous..... 11. *R. williamsii.*

B. Flowers yellow.

1. Leaves acuminate; pistil about half as long as the stamens; anthers appendaged..... 13. *R. brachygynum.*
2. Leaves acute or rounded; pistil about as long as the stamens.
   a. Anthers appendaged ..... 14. *R. loheri.*
   b. Anthers not appendaged..... 15. *R. leytense.*

Subsection 5. *Leiovireya.* Leaves leathery; corolla colored, glabrous without; ovary glabrous or moderately lepidote; filaments usually pubescent, anthers large, linear, without appendages.

A. Filaments pubescent.

1. Disk crowned with abundant hairs.
   a. Ovary glabrous; flowers usually orange. 16. *R. clementis.*
   b. Ovary lepidote; flowers yellow.... 18. *R. xanthopetalum.*
2. Disk crowned with very few hairs; flowers red. 17. *R. spectabile.*
3. Disk strictly glabrous, flowers salmon pink..... 19. *R. schadenbergii.*

B. Filaments, disk, and ovary strictly glabrous; flowers yellow ..... 20. *R. loboense.*

Subgenus *Anthodendron* Endlicher.

Section *Tsutsutsi* G. Don. No parts lepidote; foliage covered with flattened hairs; seeds not appendaged. A single species, flowers pink to purplish, small, stamens 10..21. *R. subsessile.*

Artificial key to the Philippine species of Rhododendron.

1. Lower surface of leaves, and bracts and ovary, brown-pubescent. 21. *R. subsessile.*

1. Leaves and bracts not brown pubescent.
   2. Ovary densely lepidote; margins of bud-scales white-ciliate.
      3. Leaves very densely lepidote beneath.
         4. Leaves elliptic to oval; terrestrial, filaments glabrous. 2. *R. apoanum.*
         4. Leaves narrowly lanceolate; epiphytes.
            5. Leaves 9 to 15 cm long; filaments pubescent.... 3. *R. nortoniae.*
            5. Leaves 5 to 10 cm long (flowers unknown)..4. *R. catanduanense.*
      3. Leaves sparsely lepidote beneath, small..... 1. *R. quadrasianum.*

2. Ovary pubescent; margins of bud-scales not white-ciliate.
3. Corolla slenderly tubular, white.....9. *R. copelandi.*
3. Corolla not slenderly tubular.
4. Flowers white.
5. Leaves acuminate, 6 to 15 cm long; anthers ovate, without appendages .....10. *R. kochii.*
5. Leaves rounded, 5 to 7 cm long; anthers ovate, with minute appendages .....12. *R. mindanaense.*
5. Leaves obtuse, 2.5 to 5.5 cm long; anthers linear, without appendages .....6. *R. vidalii.*
5. Leaves linear, 2 to 3.5 cm long; anthers linear, without appendages .....8. *R. taxifolium.*
4. Flowers yellow.
5. Pistil about half as long as the stamens; leaves herbaceous, acuminate, about 10 cm long, drying yellow. 13. *R. brachygynum.*
5. Pistil about as long as the stamens; leaves obtuse, slightly fleshy, drying brown.
6. Corolla membranous when dry, anthers not appendaged. 15. *R. leytense.*
6. Corolla chartaceous when dry, anthers bearing minute basal appendages .....14. *R. loheri.*
4. Flowers red.
5. Corolla about 2.5 cm long, pubescent.....7. *R. whiteheadi.*
5. Corolla about 1 cm long, glabrous.....5. *R. bagobonum.*
2. Ovary glabrous to moderately lepidote, margins of bud-scales not white-ciliate.
3. Flowers white; leaves herbaceous, slightly acuminate; filaments, ovary, and disk glabrous.....11. *R. williamsii.*
3. Flowers colored; leaves leathery, acute or rounded.
4. Filaments, ovary, and disk glabrous; flowers yellow. 20. *R. loboense.*
4. Filaments hairy.
5. Ovary lepidote, disk bearing hairs; flowers yellow. 18. *R. xanthopetalum.*
5. Ovary glabrous.
6. Disk bearing hairs, slightly wider than the ovary; flowers usually orange.....16. *R. clementis.*
6. Disk practically glabrous, much wider than the ovary; flowers red .....17. *R. spectabile.*
6. Disk glabrous; flowers salmon-pink.....19. *R. schadenbergii.*

Subgenus EURHODODENDRON Endlicher

This is the main division of the genus, including the rhododendrons with the exception of the azaleas and a series of minor groups. The group can scarcely be defined by description. The present treatment of the group, as to limits and subdivisions, follows the work of Drude [1] and of Wilson.[2]

[1] In Engler and Prantl, Natürl. Pflanzenf. 4 [1] (1897) 35–37.
[2] Journ. Arn. Arb. 5 (1924) 86.

Section LEPIPHERUM G. Don

Rhododendron Sect. I *Ponticum* and IV *Lepipherum* G. DON, Gen. Syst. 3 (1834) 843–845.

Rhododendron Sect. III *Eurhododendron* DC., Prodr. 7[2] (1839) 721–725.

Rhododendron Sect. *Osmothamnus* MAXIMOVICZ, Mém. Acad. Imp. Sci. St. Pétersb. VII 16[9] (1870) 15.

Rhododendron Ser. I *Eurhododendron* (in part), II *Graveolentes*, and III *Osmothamnus* HOOK. f., Gen. Pl. 2[2] (1876) 600–601.

Rhododendron Subg. I *Eurhododendron* Sect. 2 *Osmothamnus* DRUDE in Engler and Prantl Natürl. Pflanzenf. 4[1] (1897) 36–37.

Rhododendron Subg. I *Eurhododendron* Sect. 2 *Lepipherum* WILSON, Journ. Arn. Arb. 5 (1923) 84–107.

Leaves persistent, more or less clothed with lepidote glands; bud-scales with white-ciliate margins; stamens 10; ovary densely lepidote; seeds with short appendages (as compared with *Vireya*) or none.

This is the type section of the genus and includes *R. ferrugineum* Linnæus, of the Alps, the type species, as well as many species in the Himalayas and China. The Malayan species, including the Philippine, are perhaps somewhat distinct, and usually have been included in the section *Vireya*.

1. RHODODENDRON QUADRASIANUM Vidal.

Rhododendron quadrasianum VIDAL, Rev. Pl. Vasc. Filip. (1886) 170; ELMER in Leafl. Philip. Bot. 3 (1911) 1106; MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 43; Philip. Journ. Sci. 1 (1906) Suppl. 111, 2 (1907) Bot. 292, 3 (1908) Bot. 382; Enum. Philip. Fl. Pl. 3 (1923) 224; MILLAIS, Rhodod. (1917) 233, 2d ser. (1924) 218.

Vidal's original description is as follows:

Fruticulus, rarius frutex; ramulis sub-angulatis, cum pulvinis foliorum dense notatis, cinereis vel junioribus brunneis. Folia sub-sessilia, obovata-oblonga aut lineare-oblonga, basi cuneata, apice rotundata vel sub-emarginata, longa 10–25 mm. lata 3–9 mm., coriacea, supra nitida, subtus ferruginea scrobi-culato-nigro-punctata. margine incrassata-revoluta. Gemmae floriferae squamis rotundatis, ciliatis. Calyx parvus, 5-dentatus vel sub-truncatus. Corol[l]a anguste campanulata, rubra, circ. 15 mm. longa; lobis 5, brevibus, rotundatis; ad lentem punctata. Stamina inclusa. Ovarium 5-lobatum, lepidotum, loculis 5. Fructus junior lobatus, rugosus, lepidotus.

819 Volcan Mayon, 1,700 m., Pr. Albay.—Cum. 804 Pr. Tayabas.

Los ejemplares que han servido para la description fueron recogidos por el Ayudante D. José Florencio Quadras. La planta de Cuming parece idéntica.

The original description may be amplified to read as follows:

Planta lignosa, aut epiphytum, aut frutex terrestris, aut arbor parva, foliis parvis, floribus parvis, rubris. Rami grisei, ra-

muli junioris graciles, minute striati, brunnei, lepidoti, leviter ad dense puberuli. Folia commutabilia, linearia ad oblanceolata vel obovata, fere sessilia, rotundata vel emarginata, coriacea, utrinque lepidota, vulgo uninervia, 5 ad plus quam 30 mm longa, 1 ad 10 mm lata, superficiebus superioribus quam inferioribus obscurioribus, nitidis, marginibus recurvis. Gemmae floriferae 5 ad 15 mm longae, bracteis suborbicularibus, apiculatis, bruneis, lepidotis, albo-ciliatis, exterioribus minoribus. Flores vulgo solitarii, interdum bini vel glomerati. Pedicelli graciles, 10 ad 20 mm longi, brunnei, lepidoti atque pubescentes, grado pubescentiae squamficationisque commutabilissimo. Calyx est discus minutus, lobis interdum manifestis. Corolla rubra, 8 ad 20 mm longa, campanulata ad tubulosa, leviter irregularis, extus lepidota atque pubescens, lobis suborbicularibus, rotundatis. Stamina tubo corollae aequantes, filamentis complanatis, omnino glabris, antheris subglobosis, poribus hiantibus. Pistillum tubo corollae aequale, ovario 2 mm longo, dense lepidoto, 5-loculare, stylo filiforme, stigmate minuto. Fructus flavus, fusiformis, 1 ad 2 cm longus, valvis in dehiscentia in medio superiore separantibus. Semina utrinque appendiculata, appendiculis incongruentibus, seminibus aequalibus.

Typus e Monte Mayon, Vidal 819; non vidi.

Habitat in montibus in omnibus Insulis Philippinis, atque in Borneo.

This is the commonest representative of the genus in the Philippines. It is exceedingly variable; on almost every mountain there is a distinct variety, but the varietal characters are inconstant. It is impossible to detect constant characters by which to distinguish *R. malindangense* and the Bornean *R. cuneifolium* Stapf from *R. quadrasianum*. Typical *R. rosmarinifolium* Vidal is distinct from typical *R. quadrasianum* but there exist several complete series of intergrades.

I propose the following definitions of subspecific groups and assignment of specimens:

A. Typical RHONDODENDRON QUADRASIANUM.

Frutex terrestris. Folia late oblanceolata, usque ad 30 mm longa, 13 mm lata. Gemmae usque ad 9 mm longae, bracteis puberulis, leviter lepidotis. Flores vulgo bini vel glomerati, pedicellis puberulentis, in fructu glabris, corolla anguste campanulata, circa 15 mm longa. Fructi glomerati, fere recti, vulgo minus quam 10 mm longi.

LUZON, Albay Province, Mount Mayon, *Bur. Sci. 6502 Robinson* (M, W) : Sorsogon Province, Mount Bagaua, *Bur. Sci. 23422 Ramos and Edaño* (M, W).

Without seeing type material, I take this large-leaved terrestrial form as typical of the species. The first specimen cited comes from the type locality, and its measurements agree very closely with those given in the original description.

B. Forma MARIVELESENSE forma nova.

Arbor parva (vulgo). Folia oblanceolata, usque ad 20 mm longa, 8 mm lata. Gemmae circa 5 mm longae, bracteis fere glabris. Flores vulgo solitarii, pedicellis puberulis, vix lepidotis, corolla tubulosa, circa 15 mm longa. Fructus circa 10 mm longi, robusti, paene recti.

LUZON, Bataan Province, Mount Mariveles, *Merrill 3215* (M, W; type of the form), *Leiberg 6302* (M), *Whitford 278, 1104* (M, W), *Merrill Decades 299* (M, C), *Elmer 6765* (M), *For. Bur. 2090 Borden* (M) : Rizal Province, *Loher 3764, 15098* (M, C) : Laguna Province, Mount Maquiling, *Loher 3764, 6188* (W), *For. Bur. 7703 Curran and Merritt* (M), *Baker s. n.* (M), *Elmer 17488* (M, W, C), *For. Bur. 28925 Sulit and Salvosa* (M) ; Mount San Cristobal, *Gates s. n.* (M) : Batangas Province, Mount Agas, *For. Bur. 7716 Curran and Merritt* (M). MINDORO, Mount Halcon, *For. Bur. 4408 Merritt* (M), *Merrill 6158* (M, W). LEYTE, *Wenzel 930* (M).

This is the commonest form, recognizable by the pedicels, which are hairy and very slightly lepidote, the small buds, etc. The specimens from Mount Halcon are not typical; they represent a transition to the next.

C. Forma HALCONENSE forma nova.

R. cuneifolium RENDLE in Journ. Bot. 34 (1896) 355; MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 43, non Stapf.

R. quadrasianum var. *intermedium* MERRILL in Philip. Journ. Sci. 3 (1908) Bot. 382; Enum. Philip. Fl. Pl. 3 (1923) 244, in part.

Suffrutex terrestris, foliis cuneatis, circa 12 mm losgis, 3 mm latis. Gemmanae circa 5 mm longae, bracteis fere glabris; pedicelli sparsim lepidoti et pubescentes.

MINDORO, Mount Halcon, *Merrill 5736* (M, W; type of the form), *Whitehead,* 1896 (M. fragm. ex Herb. Mus. Brit.).

Occurs only at high altitudes. Distinguished from most of the other forms by the small and narrowly but definitely cuneate leaves.

D. Forma NEGROSENSE forma nova.

Aut arbores, aut frutices, aut epiphyta. Folia oblanceolata, emarginata, 15 ad 25 mm longa, circa 8 mm lata. Gemmae plus quam 5 mm longae bracteis sparsim pubescentibus. Flores saepe bini, pedicellis sparsim lepidotis et pubescentibus, corollis campanulatis, circa 13 mm longis. Fructus rectus vel arcuatus, robustus, circa 15 mm longus.

NEGROS, Canlaon Volcano, *Banks* (M), *Merrill 247* (M, W; type of the form); Mount Mapara, *For. Bur. 13616 Curran and Merritt* (M, W); Cuernos Mountains, *Elmer 9738* (M, W).

E. Var. MALINDANGENSE (Merrill) comb. nov.

Rhododendron malindangense MERRILL in Philip. Journ. Sci. 3 (1908) Bot. 256, 381; Enum. Philip. Fl. Pl. 3 (1923) 244; MILLAIS, Rhodod. (1917) 206, 2d ser. (1924) 183.

Merrill's original description is as follows:

Arbor parva, ramis glabris, griseis, ramulis junioribus brunneis, puberulis; foliis coriaceis, pallidis, oblongo-ovatis, apice rotundatis vel emarginatis, basi cuneatis, utrinque squamulis glandulosis paucis notatis; bracteis ovatis, coriaceis, acutis, margine breviter ciliato excepto glabris; floribus solitariis, 2 cm longis, tubo cylindraceo; staminibus 10, inaequalibus, glabris; ovario 5-loculare, dense lepidoto.

A small tree about 7 m high, the branches terete, grayish, glabrous, the younger branches reddish-brown, puberulent. Leaves coriaceous, pale, oblong-ovate, the apex rounded or emarginate, the base cuneate, alternate or subverticillately arranged at the apices of the branchlets, glabrous except for the few scattered glandular scales on both surfaces, 1.5 to 3 cm long, 7 to 10 mm wide; nerves nearly obsolete; petioles 2 to 3 mm long. Bracts ovate, brown, rather thin, 6 mm long or less. Flowers red, solitary, few, the pedicels slender, 6 to 7 mm long, puberulent or pubescent. Calyx a small disk about 1.5 mm in diameter. Corolla 2 cm long, 4 to 5 mm in diameter, cylindrical, slightly lepidote, the lobes 5, ovate, rounded, 5 to 6 mm long, 4 to 5 mm wide, somewhat spreading. Stamens 10, unequal; filaments glabrous; anthers 1.4 mm long. Ovary oblong, 5-celled, about 3.5 mm long, densely lepidote; style glabrous, about 18 mm long.

MINDANAO, Province of Misamis, Mount Malindang, *For. Bur. 4705 Mearns & Hutchinson*, May, 1906. Common in forests at about 1,800 m. alt.

MINDANAO, Misamis Province, Mount Malindang, *For. Bur. 4705 Mearns and Hutchinson* (M, W): Agusan Province, Mount Urdaneta, *Elmer 13695* (M, W, C): Bukidnon Province, Mount Candoon, *Bur. Sci. 38929 Ramos and Edaño* (M, W). CAMIGUIN, Camiguin Volcano, *Bur. Sci. 14661 Ramos* (M, W).

Distinguish chiefly by the length of the tubular corolla. The buds are rather large, the scales slightly lepidote and some-

times very slightly hairy. The pedicels are lepidote as well as pubescent.

F. Forma DAVAOENSE forma nova.

Suffrutices terrestres, foliis fere obovatis, emarginatis, 15 mm longis, 8 mm latis, venulis manifestis. Gemmae 6 mm longae, bracteis fere glabris. Flores solitarii, pedicellis lepidotis et puberulentis, corolla tubulosa, 20 ad 25 mm longa. Fructus rectus vel arcuatus, 10 ad 15 mm longus.

MINDANAO, Davao Province, Mount Apo, *Williams 2543* (M, W; type of the form), *De Vore and Hoover 287* (M), *Copeland 1036* (M), *Mearns* (W), *Elmer 11656* (W), *Clemens 15652* (C): Cotabato Province, Mount Matutum, *Copeland s. n.* (M).

Describing his specimen cited above, Elmer remarks as follows, under the heading *Rhododendron quadrasianum* Vidal:

> A stocky tree in a dense moss covered forested basin of Apo at 6,500 feet, near Baclayan, a cold and alpine camping place; wood hard and reddish toward the center, covered with brown shredded bark; leaves suberect, numerous, shining, bright green above, much paler and punctate beneath; flowers not numerous, bright blood red, pendulous, 0.5 inch long or longer, cylindric. "Tongog" is the Bagobo name.

Distinguishable from variety *malindangense* by the size and shape of the leaves.

G. Var. INTERMEDIUM Merrill.

Var. *intermedium* MERRILL in Philip. Journ. Sci. 3 (1908) Bot. 382; Enum. Philip. Fl. Pl. 3 (1923) 244.

Arbor parva, foliis parvis superne valde convexis, 10 mm longis, 2 mm latis. Gemmae 3 mm longae, bracteis glabris. Flores solitarii, pedicellis minute hirsutis, minime lepidotis, corollis campanulatis, 10 mm longis. Fructus circa 8 mm longi.

LUZON, Zambales Province, Mount Tapulao, *For. Bur. 8063 Curran and Merritt* (M, W; type of the variety), *Bur. Sci. 5082 Ramos* (M), *For. Bur. 8086 Curran and Merritt* (M); Mount Pinatubo (specimens with larger leaves), *Bur. Sci. 2539 Foxworthy* (M), *Clemens 17474* (C): Mountain Province, Benguet Subprovince (specimens with larger buds), *Bur. Sci. 5722 Ramos* (M), *Bur. Sci. 40316 Ramos and Edaño* (M, W), *For. Bur. 15840 Curran and Merritt* (M): Abra Province, Mount Paraga (leaves and buds larger than the type), *Bur. Sci. 7104 Ramos.*

The specimens here cited are not alike in all respects, but all have glabrous bud-scales and pedicels which are hairy but not lepidote. The group is very close to var. *rosmarinifolium.*

H. Var. ROSMARINIFOLIUM (Vidal) comb. nov.

Rhododendron rosmarinifolium VIDAL, Rev. Pl. Vasc. Philip. (1886) 172; MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 43; Philip. Journ. Sci. 2 (1907) Bot. 292, 3 (1908) Bot. 382; Enum. Fl. Pl. Philip. 3 (1923) 245; MILLAIS, Rhodod. (1917) 236, 2d ser. (1924) 225; RENDLE in Journ. Bot. 34 (1896) 355.

Vidal's original description is as follows:

Frutex vel fruticulus; ramis validis, teretibus, cortice cinereo; ramulis rufo-brunneis, rimosis. Folia oblongo-linearia, basi in petiolum brevissimum angustata, apice rotundata vel emarginata, longa 1-2 cm. lata 3-5 mm., margine revoluta, supra nitida; subtus ochracea ferrugineo-punctata, aven a [misprint for avenia]; nervo medio subtus prominente, ferrugineo. Gemmæ floriferæ perulatæ; squamis rotundatis, ciliolatis. Flores rubri, 1 cm. longi, pedicellati; pedicellis pilosis. Calyx obsoletus vel parvus, patelliformis, obscure dentatus. Corolla campanulata; lobis 5 brevibus, rotundatis. Stamina 10, exserta. Ovarium lepidotum. Capsula 5-valvis, valvis lignos s [misprint for lignosis] dein recurvatis; cylindraceo-lobata. basi leviter angustata, 10–15 mm. longa 3 mm. lata, pedicello paulum longior. Semina minuta, texta utrinque in appendiculum subulatum producta, ad lentem tenuiter striata.

1530 Distr. Bontoc (N. v. *Vicbiqui.*)

LUZON, Mountain Province, Benguet Subprovince, Mount Santo Tomas, *Elmer 5798* (M, W), *Williams 1335* (M, W), *For. Bur. 14167 Merritt* (M), *McClure 16014* (C), *Merrill 11744* (M, W), *For. Bur. 25129 Leaño* (M, W), *Bur. Sci. 45095 Ramos and Edaño* (M), *Clemens 5880* (C); La Trinidad, *Elmer 6377* (M, W); Baguio (?), *Elmer 14285* (M, W), *Elmer 8588* (W); Pauai, *Bur. Sci. 31988 Santos* (M, W), *Bur. Sci. 8423 McGregor* (M); no specific locality, *Loher 3767*: Lepanto Subprovince, Mount Data, *For. Bur. 14453 Darling* (M, W), *For. Bur. 10949 Curran* (M): Bontoc Subprovince, Mount Caua, *Bur. Sci. 38072 Ramos and Edaño* (M).

The Mountain Province is the home of several distinct linear-leaved forms of *R. quadrasianum.* The commonest of these, and the one which I regard as typical of Vidal's *R. rosmarinifolium,* is represented by the specimens cited above. These have buds about 7 millimeters long, the scales lepidote, sometimes hairy in addition; pedicels hairy and lepidote; flowers commonly clustered.

I. Forma PULOGENSE forma nova.

Suffrutices ad 1 m alti, interdum epiphytici. Folia linearia ad ovalia, usque ad 15 mm longa, 5 mm lata. Gemmae ad 11 mm longae, squamis lepidotis et minute puberulentibus. Flores vulgo glomerati, pedicellis lepidotis, non pubescentibus, corollis campanulatis, 10 ad 15 mm longis. Fructus circa 8 mm longi.

LUZON, Mountain Province, Benguet Subprovince, Mount Pulog, *Bur. Sci. 44944 Ramos and Edaño* (M, C; type of the form); Mount Santo Tomas, *For. Bur. 5034 Curran* (M), *Merrill 11744* (C), *Bur. Sci. 40095 Ramos and Edaño* (C); Pauai and neighborhood, *Merrill 4752* (M, W), *Clemens 16394* (C): Lepanto Subprovince, Bauko, *Vanoverbergh 277* (M): Ifugao Subprovince, Mount Polis, *Bur. Sci. 19736 McGregor* (M, W).

J. Forma BANAHAOENSE forma nova.

Frutex parvus, foliis anguste ellipticis, retusis, usque ad 30 mm longis, 7 mm latis. Gemmae 6 mm longae, bracteis sparse puberulis. Pedicelli pubescentes, sparse lepidoti. Flores solitarii vel bini. Corolla aurantiaca, tubuloso-campanulata, circa 10 mm longa. Fructus robusti, 10 mm longi.

LUZON, Laguna Province, Mount Banahao, *Cuming 804* (M; type of the form), *For. Bur. 7888 Curran and Merritt* (M), *Loher 6178, 13682* (M), *Bur. Sci. 19588 Ramos* (M, W), *Bur. Sci. 9847 Robinson* (M), *Quisumbing 1312* (M).

Common on the summit of Mount Banahao. Resembles var. *rosmarinifolium*, but is widely separated geographically and has somewhat larger leaves.

The following extra-Philippine groups are to be mentioned:

K. Var. CUNEIFOLIUM (Stapf) comb. nov.

Rhododendron cuneifolium STAPF in Trans. Linn. Soc. Bot. 4 (1894) 198, t. 15, f. B, 3; GIBBS in Journ. Linn. Soc. Bot. 42 (1914) 104; MERRILL, Enum. Bornean Pl. (1921) 461; MILLAIS, Rhodod. (1917) 150, 2d ser. (1924) 121; RENDLE in Journ. Bot. 34 (1896) 355.

Stapf's original description is as follows:

Arbor humilis. Ramuli *graciles*, novelli badii, demum albo-cinerascentes. Folia petiolo 1 lin. longo suffulta, *obovato-cuneata*, 6–8 *lin. longa, superne* 2 *lin. lata*, basi longe cuneatim in petiolum attenuata, apice rotundata, emarginata, margine leviter recurvo, impresso-punctata, coriacea, utrinque sparsim lepidota, supra demum glabrata, lucida, uninervia, costâ supra impressâ. Flores terminales solitarii vel bini e gemmâ perulatâ, ovoideâ, acutâ, 2 lin. longâ. Perulæ paucæ, ovatæ, exteriores breviores, sericeo-ciliatulæ. Pedicelli filiformes, 2 lin. longi, *dense lepidoti*. Calyx breviter 5-lobatus, lepidotus. Corolla rubra, *tubulosa, superne sensim leviterque dilatata*, 5 *lin. longa*, extus lepidota; lobi 1–1½ lin. longi, porrecti (an semper?), ovati, margine suberosuli. Stamina 10; filamenta filiformia, glabra, breviter exserta; antheræ ovato-globosæ, ½ lin. longæ. Ovarium dense lepidotum; stylus tenuis, glaber, 3 lin. longus.

At 7000 feet[3] (*Haviland*, 1180).

[3] On Mount Kinabalu, British North Borneo—H. F. C.

Allied to *R. Vidalii*, Rolfe, *R. apoanum*, Stein, *R. rosmarinifolium*, Vid., and *R. quadrasianum*, Vid., but distinct by the very narrow cuneate leaves and the rather tubulose corolla. Of these I know *R. rosmarinifolium* only from Vidal's description; I have seen the other three. According to Vidal, *R. rosmarinifolium* differs by robust branches, oblong linear leaves, smaller bell-shaped flowers, and hairy pedicels. *R. apoanum* is a native of Mindanao, *R. quadrasianum* inhabits South and Central Luzon, whilst *R. Vidalii* (=*R. verticillatum*, Vidal, non Low) and *R. rosmarinifolium* were found in North Luzon. They all come very closely together.

Rhododendron vidalii is actually very distinct from the *R. quadrasianum* group; while *R. apoanum* is a rather close relative, having ciliate bud-scales, glabrous filaments, and subglobose anthers with gaping pores, but is quite distinct. I have not seen typical material of Stapf's species, with lepidote pedicels; but all the characters mentioned by Stapf as distinctive are shared by one or more of the varieties mentioned above.

I have not seen type material of *R. quadrasianum* var. *subspathulatum* Ridley. The original description is very inadequate. The specimens that I have seen under this name constitute an undescribed species in a different group.

The descriptions of *Rhododendron quadrasianum* var. *borneense* J. J. Smith and *R. rosmarinifolium* var. *villosum* J. J. Smith, mentioned by Merrill,[4] from Dutch Borneo, do not seem to have been published; at least I have been unable to locate them.

2. RHODODENDRON APOANUM Stein.

Rhododendron apoanum STEIN in Verhandl. schles. Gesellsch. vaterländ. Cultur Breslau 1883 (non vidi); Gartenflora 34 (1885) 194, t. 1196; ELMER in Leafl. Philip. Bot. 3 (1911) 1107; MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 43; Philip. Journ. Sci. 3 (1908) Bot. 380; Enum. Philip. Fl. Pl. 3 (1923) 243; MILLAIS, Rhodod. (1917) 115, 2d ser. (1924) 83; VIDAL, Rev. Pl. Vasc. Filip. (1886) 172.

Rhododendron sp. VIDAL, Sinopsis Atlas (1883) 30, t. 60, f. E.

Rhododendron jasminiflorum F.-VILLAR, Novis. App. (1883) 353, non Hooker.

Stein's description (1885) is as follows:

R. apoanum Stein (in Verhandlungen der schlesischen Gessellschaft für vaterländische Cultur in Breslau 1883): Zwergstrauch, mit aufsteigenden reich verzweigten Aesten, die jüngern Aeste dicht braunschuppig bekleidet. Blätter kurz gestielt verkehrteiförmig, allmählig in den Blattstiel verlaufend, abgestumpft, ganzrandig, Blattrand zurückgeschlagen, Oberseite glänzend dunkelgrün, dicht schuppig-grubbig punktirt und

[4] Enum. Born. Pl. (1921) 462, 463.

dadurch in trockenen Zustande weisslich schimmernd, Unterseite glänzend broncefarben, fast goldschimmernd dicht schuppig bekleidet. Blüthen in dichten Doldensträussen, kurz getielt, Stiele und Kelche dicht broncirt schuppig. Kelch klein, fünfzackig. Blumenröhre cylindrischglockig, unbekleidet, Saum wenig ausgebreitet, fünflappig, Lappen fast kreisrund, leicht herezförmig eingebuchtet, wellig-bogig, purpurroth. Staubfäden zu 5, nicht vortretend. Griffel kurz, g[e]rade, auf kruzen dickem Fruchtknoten, Narbe kopfförmig. Frucht ??

Unter dem Gipfel des Vulkan Apo auf Sud-Mindanao (Philippinen) bei 3,000 m weit verbreitet. (Dr. Schadenberg, February 1882.) Die schöne Pflanze erinnert in der Tracht so an unser alpines Rhododendron ferrugineum, das es leicht erklärlich ist, wenn unser Sammler sie im ersten Augenblick auch dafür hielt und leider nur spärliches Material dieser reizenden Alpenrose sammelte, welche sich eng an Rhododendron setusum und lepidotum aus dem Himalaya anschliesst und diese Arten mit unseren Alpenrosen verbindet.

Die Astbildung und der ganze Wuchs des nur halbmeterhohen Strauches erinnert ganz an unsere Alpenrosen, während froilich die ebenso dichte wie schöne Schuppenbekleidung, welche die ganze Pflanze wie mit Bronce übergossen erscheinen lässt, den Botaniker auf den ersten Blick die neue Art erkennen lässt. Die festen, lederigen Blätter messen bis 6 cm Länge bei 2,5 cm Breite und sitzen 1–1,5 cm langen Stielen, in welche sich die Blattspreite allmählich zusammenzieht. Nach der Spitze zu zieht sich das Blatt plötzlich zusammen und endet in eine kurze, breit abgerundete Spitze. Blüthen zu 6–10, fast von der Form des Rhododendron hirsutum, aber völlig unbekleidet. Blumenröhre bis 2 cm lang, Saum bald zurückgeschlagen, ausgebreitet etwa 2 cm in Durchmesser, von prächtig purpurrothe Färbung.

MINDANAO, Davao, Province, Mount Apo, *DeVore and Hoover 239, 375* (M), *Copeland 1045, 1140* (M, W), *Mearns s. n.* (W), *Williams 2559* (M), *Elmer 10630, 11386* (M, W), *Clemens 15653, 15667* (C): Bukidnon Province, Mount Lipa, *Bur. Sci. 38497 Ramos and Edaño* (M, C): Agusan Province, Mount Urdaneta, *Elmer 13754* (M).

Elmer's field notes are of interest:

Field note for 11386:—An erect shrub, 3 feet high; stems usually several, numerously branched above the middle; the suberect twigs grayish brown; leaves numerous, ascending, grayish brown beneath or the young ones scurfy brown on both sides; flowers terminal or upon short special stalks, quite numerous and forming dense blood red cluster; corolla broadly cylindric, 0.75 inch long, upon glandularly scurfy pedicels. This the Bagobos call "Calumping-busau."

To these descriptions the following notes may be added. The bud scales have white-ciliate margins. The outer bud scales are densely lepidote; the inner are progressively larger and less lepidote. There are 6 to 15 flowers in the umbel. The corolla is definitely lepidote externally, although very sparingly, often

with only a single scale near each sinus of the limb. The stamens are represented as eight in number in the figures of both Stein and Vidal. I have dissected the flowers from about a dozen collections, and have found the stamens to be always ten in number. The pistil is 7 to 9 mm long, densely lepidote for about two-thirds of its length. I have seen fruit only on Williams's collection. The fruit is about 2 cm long, and is that of a typical *Vireya*: the five linear valves break loose at the apex and become recurved, while the filiform placentæ tear loose, except at the apex, from the central column. Each seed is more than 1 mm long and bears a filiform appendage 2 mm long at each end.

As to variations, Elmer remarks as follows:

> Represented by numbers 11886 and 10630, *Elmer*, Todaya (Mount Apo), Mindanao, August and May, 1909.
>
> The former is typical *R. apoanum Stein*. The latter number was collected on a wooded ridge at 7,500 feet of mount Calelan, and had a subscandent epiphytic habit. *Stein's* species came from the chaparral region of Apo, since none of the former botanists have explored mount Calelan Number 10630 is somewhat similar to *R. mertonae Merr.* which the writer also collected in southern Negros.

The existence of two forms, suggested by Elmer, is evident in the considerable body of material that I have examined. One of the forms has entire leaves, of the dimensions given in the original description. These leaves are spreading rather than ascending, just as in the plant from which Stein's drawing was made. This is, I believe, to be regarded as the typical form. To it belong *Elmer 10630*, as well as the specimen from Bukidnon and part of the material from Mount Apo. The other (and apparently commoner) form has slightly smaller leaves, which are very feebly dentate toward the apex, and tend to ascend strictly. There is not the least difference in the flowers; I believe that not even a varietal distinction can be made. The specimen of *Copeland 1440* in the herbarium of the Bureau of Science has both forms mounted on the same sheet, with the note in the collector's handwriting, "If 2 species, they have the same range."

The specimen from Agusan is without flowers. It is possible that it represents an undescribed species; the leaves are narrower and more scattered than those of specimens from the type locality.

3. RHODODENDRON NORTONIAE Merrill

Rhododendron nortoniae Merrill in Philip. Journ. Sci. 1 (1906) Suppl. 220; Enum. Philip. Fl. Pl. 3 (1923) 244; Elmer, Leafl. Philip. Bot. 3 (1911) 1107; Millais, Rhodod. (1917) 218, 2d ser. (1924) 195.

An epiphyte erect with lanceolate to oblong-lanceolate, coriaceous, acuminate leaves which are densely brown lepidote beneath, and terminal umbellate-like fascicles of tubular crimson flowers about 4.5 cm. long. Branches terete, brown, the branchlets densely covered with round, dark-brown scales. Leaves 9 to 15 cm. long, 1.5 to 3.5 cm. wide, narrowed below to the acute base and above to the rather long slender apex, entire, the margin slightly revolute, glabrous and shining above, densely covered with small round dark-brown scales beneath; lateral nerves 5 to 6 on each side of the midrib distant, indistinct; petioles densely lepidote, stout, 1 cm. long or less. Flowers terminal, about 12 flowered, the bud bracts coriaceous, glabrous except the slightly pubescent margins, ovate to oblong-ovate, acute, 1 to 1.5 cm. long. Pedicels 1.5 cm. long, glabrous, the bracts oblong to spatulate, the bracteoles linear, caducous. Calyx a disk about 2 mm. in diameter, obscurely 5-toothed, the teeth rounded, small. Corolla 4.5 cm. long, waxen, the tube cylindrical, about 2.5 cm. long, scarcely inflated or enlarged above, slightly curved, 6 to 7 mm. in diameter, the limb 5-lobed, the lobes broadly ovate to obovate, rounded, 1 cm. long. Stamens 10, erect, oblong, 3.5 mm. long. Ovary narrowly oblong, the style elongated filiform, densely brown lepidote.

Mountains of Lake Lanao, Camp Keithley (590 *Mrs. Clemens*) April, 1906. Altitude about 800 m. Epiphytic on a large tree, associated with an epiphytic *Vaccinium*.

At the collector's request this distinct species is named in honor of Miss Norton, of the Pacific Grove (Calif.) Museum, the collector's interest in botanical work having been largely inspired by her.

Rhododendron nortoniae is apparently very rare. I have seen no specimen except the type in the herbarium of the Bureau of Science collected twenty-two years ago. There is no record of another collection except a statement by Elmer that he has collected this species in southern Negros.

The species is related to *R. apoanum*, but perhaps not very closely. An interesting difference is found in the stamens, which are in this species densely brown-pubescent in the lower part.

4. RHODODENDRON CATANDUANENSE Merrill MS. sp. nov.

Fruticulus epiphyticus, dense lepidotus ad ramulos juniores, petiolos, faciesque inferiores foliarum; foliis ad nodos confertis, repandis, coriaceis, anguste-ellipticis, utrinque attenuatis, supra nitidis, 5 ad 10 cm longis, 1 ad 2 cm latis, petiolis 1.5 cm longis;

floribus ignotis (terminalibus, 15 in umbella?); fructibus subgeneris Vireyae typicalibus, 5 ad 8 cm longis, dense lepidotis; pedicellis crassis, 2 cm longis; seminibus fusiformibus, plus quam 1 mm longis utrinque appendiculatis, appendiculis seminibus aequantibus.

CATANDUANES, Mount Mariguidon, *Bur. Sci. 30346 Ramos*, November 14, 1917, altitude 270 meters.

This species is certainly distinct from any other described from the Philippines and appears to be very rare. It is related to *R. apoanum* and *R. nortoniae;* the leaves closely resemble those of the latter species, but are smaller.

These four Philippine species represent three distinct series. The first, and apparently the most primitive, is characterized by moderately lepidote leaves, filiform styles, and glabrous filaments. Close to *R. quadrasianum*, the Philippine representative, are *R. retusum* (Bl.) Ben. and perhaps *R. ericoides* Low, the former widely distributed in the Malay region, the latter confined to British North Borneo. The leaves of *R. retusum* are larger than those of *R. quadrasianum*, the fruits are similar, and the seeds bear shorter appendages, one of the appendages on each seed being fimbriate.

The second series is characterized by densely lepidote leaves and pubescent filaments; the styles are various. Of this group *R. nortoniae*, with filiform styles, seems to be an extreme example; I assume that the flowers of *R. catanduanense* are very similar. The Javan *R. zollingeri* J. J. Sm., and the Bornean *R. acuminatum* Hook f., *R. durionifolium* Becc., *R. lineare* Merr., *R. mjobergii* Merr., and *R. variolosum* Becc. are similar but have stouter styles.

The third series is characterized by densely lepidote leaves, glabrous filaments, and stout styles. The Philippine *R. apoanum* is as Merrill [5] points out, very close to *R. malayanum* Jack (*R. tubiflorum* and *celebicum* DC., Miq., *Vireya* Blume); the latter is, however, a species of low elevations, with pistils nearly 2 cm long, lepidote for less than half their length.

The whole group is a natural one. The characters of the budscales, ovaries, fruits, and seeds lead me to include it in the section *Lepipherum;* I have, however, hesitated, because I am not certain that the various subsections of *Vireya*, described below, have a common ancestor outside of this group.

[5] Enum. Philip. Fl. Pl. 3 (1923) 243.

Section VIREYA Blume as genus

Vireya BLUME, Bijd. (1826) 854–855.
Vireya G. DON, Gen. Syst. 3 (1834) 846.
Rhododendron Subg. I *Eurhododendron* Sect. 2 *Vireya* DRUDE in Engler and Prantl Natürl. Pflanzenf. 4[1] (1897) 36.
Not *Rhododendron* Series I *Eurhododendron* Subseries 8 (*Vireya* Blume) HOOKER f., Gen. Pl. 2 (1876) 600.

A large group of which the type is *R. javanicum* (Bl.) Benn. The group ranges from the Malay Penisula, through the Malay Archipelago, to New Guinea, and the Philippines, with one species in Formosa [6] and possibly one in the Himalayas.

The leaves are always moderately lepidote. The bud-scales are typically large, rounded, and entire; in a single form, which I regard as referable here, the margins are white-ciliate. The corolla is usually rather broadly tubular with a flaring mouth. Typically the ovary is pubescent; it varies to moderately lepidote or glabrous. The seeds bear filiform appendages longer than themselves.

My subseries 1 and 2 fall within this definition; they are placed here provisionally, although I suspect them of an independent descent from section *Lepipherum*. For the rest, I have confidence that the group is a natural one.

Subsection 1, MALESIA

Filaments glabrous, ovary pubescent. The following is the type species.

5. RHODODENDRON BAGOBONUM sp. nov.

Fruticulus epiphyticus?, ramulis junioribus brunneis, sparse lepidotis. Folia pseudoverticillata, sessilia, oblanceolata, 2 cm longa, apice acuta, basi cuneata superne atroviridia, subtus lucida, utrinque lepidota, venulis obscuris vel obsoletis. Bracteae angustae, glabrae, basi in tomentum brevum implicatae. Flores solitarii, terminales. Pedicelli 5 mm longi, lepidoti pubescentesque. Calyx vix evidente. Corolla rubra, 1 cm longa, glabra, campanulata, lobis 5, parvis, rotundis. Ovarium 5-loculare, dense albo-pubescente. Fructus fusiformis, 2 cm longus, pubescens. Semina fulva, fusiformia, minus quam 1 mm longa, utrinque appendiculata; appendiculis filiformibus, 3 mm longis. (Bagobones: tribus in quarum finibus planta crescit.)

MINDANAO, Davao Province, Mount Apo, *Mrs. Clemens*, June, 1924, type in the herbarium of the University of California, sheet No. 268274.

[6] Wilson, Journ. Arn. Arb. 6 (1925) 173.

This distinct species is described from a single specimen, which bore, unfortunately, only a single flower, and that partly destroyed by insects. I believe, but cannot affirm confidently, that the plant is an epiphyte, and that there are ten stamens with glabrous filaments. It resembles superficially *R. quadrasianum*.

Rhododendron bagobonum is decidely distinct from all other Philippine species. It is close to the Bornean form which I have seen under the name of *R. cuneifolium* var. *subspathulatum* Ridley. The latter has bud-scales with ciliate margins and appears to connect *R. bagobonum* with *R. quadrasianum*. To the same group I refer the New Guinean *R. linnaeoides* and *R. torricellense* of Schlechter, of which I have seen cotypes. These have acuminate bud-scales with brown-fimbriate margins; they seem to represent a transition to the following section.

Subsection 2. LINEARANTHERA

Bud-scales acuminate, brown-fimbriate. Corolla lepidote or hairy without, hairy within. Ovary and stamens pubescent. Anthers linear. The type species is *R. vidalii* Rolfe.

6. RHODODENDRON VIDALII Rolfe.

Rhododendron vidalii ROLFE in Journ. Bot. 24 (1886) 348; MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 43; Philip. Journ. Sci. 1 (1906) Suppl. 111, 3 (1908) Bot. 381; Enum. Philip. Fl. Pl. 3 (1923) 245; MILLAIS, Rhodod. (1917) 258, 2d ser. (1924) 257.

Rhododendron verticillatum VIDAL, Rev. Pl. Vasc. Filip. (1886) 171; Ceron, Cat. Pl. Herb. Manila (1892) 106, non Low.

Rhododendron lussoniense RENDLE in Journ. Bot. 34 (1896) 356; MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 43; MILLAIS, Rhodod. (1917) 204, 2d ser. (1924) 179.

Vidal's original description is as follows:

Frutex glaber; cortice albicante; ramulis sæpissime verticillatis, nodosis, junioribus rufo-brunneis. Petioli brevissimi circ. 3 mm., validi, complanati, rugosi. Folia e basi cuneata, oblonga vel obovato-oblonga, apice rotundata vel subemarginata, longa 25-45 mm. lata 10-20 mm. margine revoluta, supra nitida, subtus ferruginea vel ochracea dense scrobiculato-punctata, coriacea, in verticillastros sæpissime disposita et ramulorum apices versus conferta. Gemmæ floriferæ majusculæ ad 15 mm. longæ, perulatæ; squamis amplis rotundatis, apice acutis vel mucronatis, brunneis pallide marginatis. Flores ad ramulorum apices glomerati, albi. Calyx parvus, patelliformis, obscure dentatus, cum pedicello villosus. Corolla alba, ad 3 cm. longa, campanulata, quinqueloba, lobis rotundatis, limbo ad 3 cm. diam. Stamina 10 inclusa vel antheris sub-exsertis. Ovarium cum stylo praeter apicem velutino-setosum vel hirsuto-setosum, pilis albidis, loculis 5 (an semper?) (Series I. *Eurhododendron*, Maxim. subser. 4).

1529 Distr. Bontoc, 1.000–1.200 m. alt. (N. v. *Lofong*.)

LUZON, Mountain Province, Ifugao Subprovince, Mount Polis, *Whitehead* (M; fragment of type of *R. lussoniense* Rendle ex Herb. Mus. Brit.), *Sandkuhl 283* (M): Bontoc Subprovince, Mount Caua, *Bur. Sci. 37983 Ramos and Edaño* (M, W): Lepanto Subprovince, Bauko, *Vanoverbergh 70* (M), Sabangan, *For. Bur. 10693 Curran* (M, W): Benguet Subprovince, Loö, *Loher 3761* (W): Isabela Province, Bayabat, *For. Bur. 18559 Alvarez* (M, W): Cagayan Province, Cagua Volcano, *Clark s. n.* (M): Abra Province, *Bur Sci 7229 Ramos* (M): Bataan Province, Mount Mariveles, *Merrill 3743* (M, W), *Whitford 452* (M, W), *For. Bur. 1591 Borden* (M, W), *Merrill 3868* (M), *Merrill Decades 300* (M, C): Rizal Province, *Loher 12586* (M, C): Laguna Province, Mount Maquiling, *Elmer 17881* (M, W, C), *McLean s. n.* (M); Lukban Cone, *Elmer 7475* (M): Batangas Province, Mount Malarayat, *For. Bur. 7839 Curran and Merritt* (M).

In a footnote to his review of Vidal's Revision de Plantas Vasculares Filipinas, Rolfe[7] remarks:

> As there is already a *Rhododendron verticillatum* Low in Journ. Hort. Soc. iii. pp. 86 & 87, with figure; Hook. Ic. Pl. t. 884; from Borneo, I propose to call this *R. Vidalii*.—R. A. R.

Rendle's original description of *Rhododendron lussoniense* is as follows:

> Lignosus, ramis glabris brunneis; foliis oblanceolatis, facie superiore glabra, inferiore squamulis glandulosis nigris notata; bracteis castaneo-brunneis, glabris, ovatis, mucronatis; pedicellis pubescentibus, flores haud æquantibus; calyce parvo patelliforme; corolla alba inter mediocres, tubo infundibuliforme cum glandulis brunneis externe notato, lobis, tubum aequantibus, cuneato-spathulatis; staminibus 10, filamentis in parte inferiore pubescentibus superne glabris; ovario piloso 5-loculare.
>
> Hab. North-west-central Luzon, highland of Lepanto.
>
> The stiff woody leafy shoots of the third season are 3 mm. in diameter, and bear the leaves crowded near the ends. The petioles are short (4–5 mm. long), the blades 4.5–5.5 cm. long, 1.2–1.7 cm. broad; the lower surface bears numerous roundish black scales. The smooth bracts are 6–12 mm. long. The pedicels are 2.5 cm. long; the flowers, which have been pink or tinged with pink, 3 cm. long and about the same across. The corymb in the single specimen is 3-flowered. The calyx is reduced to a flattened plate with 5 scarcely indicated lobes. The corolla-tube and lobes are each 2 cm. long; the former is 1 cm. across the mouth, the latter are entire, with a slightly emarginate apex, and 16 mm. broad in the spreading upper part. The stamens including the anthers (4 mm.) are 2.5 cm. long, of equal

[7] Journ. Bot. 24 (1886) 348.

length with the pistil. The ovary and lower part of the columnar style have numerous short hairs.

Near the Indian *R. formosum* Wall., but distinguished by its smaller flowers.

Rendle's description is seen to agree with Vidal's except for slight variations in some of the measurements, and in the statement that the flowers are pink. This is an error: the type specimen of *R. lussoniense* (seen by Merrill) bears the field note, by Whitehead, "flowers pure white." As the type locality falls within the type region of *R. vidalii*, Merrill (1908) reduced Rendle's species; and no evidence has appeared, in the numerous collections made since, that it exists as a distinct race.

As occurring in the Mountain Province, this is a shrub 1 to 2 meters high with white flowers and narrow leaves which are green beneath. The scales on the leaves are about 0.1 mm in diameter, and 0.25 to 0.5 mm apart. The bud scales are brown and minutely and sparsely sericeous toward the middle part of their surface otherwise sparsely lepidote; they are sharply acuminate and have minutely fimbriate margins. The flowers are usually in clusters of two or three, but may be solitary. The corolla tube is lepidote without and sparsely hairy within, and the stamens, with dark, narrow anthers, are white-hairy toward the base. The fruits are 1.5 to 2 cm long, pubescent; the valves in dehiscence become recurved, and the placentæ become completely detached from the central column. The seeds are slightly more than 1 mm long and bear appendages about as long as themselves.

The specimens from Cagayan and Isabela are almost indistinguishable from those from the Mountain Province, but the pedicels are glabrescent and lepidote. The specimen from Abra has peculiarly small flowers. The specimens from Bataan, Rizal, Laguna, and Batangas are sometimes described in the field notes as epiphytes and have shorter, more nearly oval, leaves, which, when dry, are reddish brown beneath. This species shows, in fact, a tendency like that of *R. quadrasianum* to assume a distinct form on each mountain top; but it does not appear worth while to separate the forms taxonomically.

7. RHODODENDRON WHITEHEADI Rendle.

Rhododendron whiteheadi RENDLE in Journ. Bot. 34 (1896) 356; MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 43; Philip. Journ. Sci. 3 (1908) Bot. 381; Enum. Philip. Fl. Pl. 3 (1923) 245; MILLAIS, Rhodod. (1917) 262, 2d ser. (1924) 260.

Rhododendron curranii MERRILL in Philip. Journ. Sci. 3 (1908) Bot. 255, 381; Enum. Philip. Fl. Pl. 3 (1923) 243; MILLAIS, Rhodod. (1917) 151, 2d ser. (1924) 121.

Rendle's original description is as follows:

Lignosus, ramis duris rigidis, ramulis glabris pubescentibus; foliis obovatis, interdum orbiculari-obovatis rarius ovalibus, apice rotundo vel emarginato, basi sæpius cuneata, facie superiore glabra atre viride, inferiore glandulis crebris punctata; bracteis ovatis obtusis minute puberulis, pedicellis validis quam flores brevioribus velut calyce pubescentibus; calyce parvo patelliforme; corolla inter mediocres atre purpurea, campanulata lobis truncate obovatis cum apice lato rotuso, æquantibus; staminibus 10 inæqualibus basi lata breviter pilosis; ovario 5-loculare conico dense piloso, stylo super basin pilosam globro apice clavato.

Hab. North-west-central Luzon, highland of Lepanto.

The woody shoots are stiff and hard, with the leaves closely crowded at their ends; shoots of the third season are 3 mm. in diameter. The short stout pedicels [*sic!* should be *petioles*] are 4–5 mm. long; the leaves 2.5–4.5 mm. [*sic!* should me *cm.*] long, 1.5 to nearly 3.5 broad. The pale brown bracts are 9–13 mm. long, the pedicels 13 mm. The deep crimson bell-shaped flowers are borne in umbels of three, and are 2.5 cm. long by 2.75 cm. across. The slightly pubescent corolla-tube is 12 mm. long; the lobes are 12 mm. long, and 12 mm. across the top. The stamens including the anthers (3 mm.) are 17–20 mm. long; the ovary 1.5 cm.

Near the Bornean *R. verticillatum* Low, but distinguished by the shape of its leaves, especially the marked tendency to a wedge-shape, the few-flowered inflorescence, and the hairy, not scaly, pedicels and ovary.

Merrill's original description of *R. curranii* is as follows:

Arbuscula 2 ad 2.5 m alta, ramis ramulis foliisque glabris; foliis coriaceis oblongo-obovatis vel oblongo-oblanceolatis, acutis vel obtusis, basi sensim angustatis; pedicellis dense hirsuto-pilosis; floribus 2.5 ad 3 cm longis, purpureo-coccineis; staminibus 10, filamentis in parte inferiore plus minus hirsutis; ovario dense piloso.

A shrub 2 to 2.5 m high, the branches light-gray or brownish, glabrous, slender, terete, the ultimate ones 1.5 to 2 mm in diameter. Leaves whorled, 4 to 6 or 7 at each node, coriaceous, oblong-obovate to oblong-oblanceolate, glabrous and shining on both surfaces, paler beneath and with scattered small glands, 2.5 to 5.5 cm long, 0.5 to 2 cm wide, apex blunt or acute, gradually narrowed towards the cuneate or somewhat decurrent base, the margins slightly revolute; nerves obscure, about 4 on each side of the midrib; petioles 2 to 4 mm long. Flowers crimson-purplish, in terminal sessile fascicles, three or four flowers at the apex of each branchlet, the bracts smooth, inbricate, deciduous; pedicels densely hirsute-pilose, 1.5 to 2 cm long. Calyx an obscurely toothed ring about 4 mm in diameter. Corolla 2.5 to 3 cm long, slightly pubescent on the outside, the tube rather broad, the lobes orbicular-obovoid, rounded or retuse, 1.3 mm [*sic!* should be *cm*] long, 1.5 mm [*sic!*] wide. Stamens 10; filaments 1.5 to 1.8 cm long, 5-celled [*sic! delete*], slightly enlarged and hirsute below, glabrous above. Ovary oblong, 5-celled, densely pilose, 5 mm long; style glabrous, about 9 mm long.

LUZON, Province of Zambales, Mount Tapulao, *For Bur. 8061 Curran*, December, 1907, in thickets on ridges at 2,000 m alt., also from the same locality *Bur. Sci. 4988 Ramos*, December, 1907.

A species closely allied to *Rhododendron lussoniense* Rendle, differing somewhat in the shape of the leaves, shorter corolla tube and lobes and different color of the flowers. Rendle speaks of the flowers of *R. lussoniense* as having been pink or tinged with pink, but Whitehead's note on the type in the Herbarium of the British Museum says "flowers pure white."

There is nothing in these descriptions to show that these species are distinct, and I can find no distinctive characters by the examination of the following specimens:

LUZON, Mountain Province, Ifugao Subprovince, Mount Polis, *Whitehead* (M), (fragm. from type in Herb. Mus. Brit.): Benguet Subprovince, *For. Bur. 15738 Curran and Merritt* (M, W): Zambales Province, Mount Tahulao, *For. Bur. 8061 Curran and Merritt* (M, W, type of *R. curranii* Merrill), *Bur. Sci. 4988 Ramos* (M, W).

This species is evidently rare or at least local. It is a low shrub, sometimes if not always epiphytic, with dark red or purple flowers. The small size of the flowers, and their color and the pubescence of the ovary and filaments, distinguish this species from the other Philippine rhododendrons. The corolla tube is sparsely hairy without and densely hairy within. The fruit and seeds are unknown.

As noted above, I do not believe that the material from Zambales (essentially a single collection, since it was gathered by members of a single expedition on successive days) is to be regarded as distinct from the material from Mountain Province. If there is any difference, it is found in the shape of the leaves, which is rather consistently oblanceolate in the Zambales form, and varies to oval or orbicular in the lower leaves of the typical (Mountain Province) form; also in the pubescence, which is slightly less dense on the corolla, and extends higher on the style, in the typical form.

The nearest Philippine relative is *R. vidalii*. In my judgment, the Bornean *R. verticillatum* Low is not a close relative; Hooker Ic. Pl. t. 884 shows the ovary of the latter as lepidote, and the filaments as glabrous.

8. **RHODODENDRON TAXIFOLIUM** Merrill.

Rhododendron taxifolium MERRILL in Philip. Journ. Sci. **30** (1926) 419.

The original description is as follows:

Frutex, epiphyticus circiter 1 m altus, ramis glabris, ramulis glabris vel obscurissime puberlis, parce lepidotis, teretibus, 1 ad 1.5 mm diametro,

internodis 1 ad 3 cm longis; foliis numerosissimis ad nodis pseudoverticillatim-confertis, coriaceis, rigidis viridibus, linearis, 2 ad 3.5 cm longis, 1 ad 1.5 mm latis, obtusis sessilibus vel subsessilibus, subtus parce lepidotis, floribus terminalibus, solitariis vel paucis, subcampanulatis, albidis, circiter 2 cm longis, extus parce lepidotis, lobis late obovatis, rotundatis, 1 cm longis.

An epiphytic shrub about 1 m high. Branches terete, glabrous, ultimate branches slender, 1 to 1.5 mm in diameter, glabrous or very obscurely puberulent, the younger ones sparingly lepidote; internodes 1 to 3 cm long. Leaves numerous, crowded in pseudoverticles at the nodes, often twenty or more in a pseudoverticel, green, linear, sessile or subsessile, obtuse, 2 to 3.5 cm long, 1 to 1.5 mm wide, rigid, coriaceous, shining beneath (at least when young), sparingly lepidote, ultimately glabrous, the margins very obscurely crenulate. Flowers subcampanulate, white, terminal, solitary or few, about 2 cm long, their pedicels pubescent, somewhat lepidote, about 1 cm long. Calyx 3 to 4 mm in diameter, lepidote and pubescent. Corolla tube about 1 cm long, 6 mm in diameter, sparingly lepidote outside, pubescent within, the lobes broadly obovate, rounded, 1 cm long. Stamens 10, subequal, the filaments 10 to 11 mm long, pubescent below, glabrous above; anthers oblong, obtuse, 2.5 mm long. Ovary oblong, pubescent, 3 mm long; style about 6 mm long, pubescent in the lower one half, glabrous above.

LUZON, Benguet Subprovince, Mount Pulog, *Bur. Sci. 44880 Ramos and Edaño* (type), *Mrs. Clemens 15763*, February, 1925, on trees in the mossy forest, altitude about 2,700 meters.

A most remarkable species strongly characterized by its numerous, pseudoverticillate, *Taxus*-like leaves, whence its specific name.

The fruits, the septicidal capsules of a typical *Virega*, are about 1 cm long.

In the character of the flowers, this species is not very different from *R. vidalii;* it is on the other hand somewhat of a puzzle to find a related species with similar leaves.

These species, peculiar as are the leaves of *R. taxifolium*, seem to form a natural group. Their affinities are by no means obvious. I suspect that the possibility of relationship to *R. formosum* Wallich and *R. verticillatum* Low, suggested by Rendle, is imaginary. Wilson compares the Formosan *R. kawakamii* Hayata with *R. vidalii;* the description of the Formosan species does not mention the bud-scales, but nevertheless shows that there is probably a close relationship. The New Guinean *R. gorumense* Schlechter and *R. hausemannii* Warburg fall in the same group; but it is hard to recognize New Guinean or Formosan species as ancestral to Philippine *Eurhododendra.* The Bornean *R. neiuwenhuisii* J. J. Smith and *R. rugosum* Low are suggestive. The latter has the leaves densely lepidote beneath with remarkable cup-shaped scales with lacerate margins and similar scales mixed with the pubescence on the ovary; this

species indicates, possibly, a direct connection to section *Lepipherum;* or the connection may be through species resembling *R. linnaeoides* and *R. torricellense* in subsection *Malesia.*

Subsection 3. SOLENOVIREYA

Rhododendron Series I *Eurhododendron* Subseries 7 HOOK. f., Gen. Pl. 2 (1876) 600.

Bud scales about 1 cm long, rounded, with entire margins; corolla tube slender, usually flaring above, usually lepidote without and hairy within; filaments hairy, anthers small, oblong, with gaping pores; ovary cylindrical, lepidote to pubescent, varying in the same species and usually obviously both; style filiform. The type species is *R. jasminiflorum* Hooker f.

9. RHODODENDRON COPELANDI Merrill.

Rhododendron copelandi MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 42; Philip. Journ. Sci. 3 (1908) Bot. 381; Enum. Philip. Fl. Pl. 3 (1923) 243; ELMER in Leafl. Philip. Bot. 3 (1911) 1105; MILLAIS, Rhodod. (1917) 148, 2d ser. (1924) 117.

The original description reads as follows:

A glabrous shrub 1 to 2 m. high, with narrowly obovate to oblanceolate coriaceous, obtuse or slightly acute, verticillate leaves, and many flowered terminal fascicles of white, fragrant tubular flowers 4 cm. long. Branches reddish brown, glabrous, the branchlets verticillate. Leaves in whorls at the nodes and apices of the branchlets, 4 to 6 cm. long, 1 to 2 cm. wide, glandular-punctate beneath, the apex abruptly acute or rounded, the base cuneate, tapering gradually to the stout petiole which is 8 mm. long. Peduncles 18 mm. long, sparingly brown lepidote and minutely pubescent. Calyx a small crenate disk 2 mm. in diameter. Corolla tube 4 cm. long, tubular, 4 mm. in diameter, not enlarged or inflated above, the limb abruptly spreading, 1.5 cm. in diameter, 5-lobed, the lobes obovate, obtuse, 5 to 6 mm. long. Stamens 10, the filaments filiform, glabrous, 4 cm. long, the anthers 1.5 mm. long. Ovary oblong, 5 to 6 mm. long, densely pubescent with short spreading hairs; style slightly pubescent throughout, 3.8 cm. long.

Type specimen No. 1439 (Copeland), Mount Apo, District of Davao, Mindanao, October, 1904; also from same locality, all specimens in flowers, No. 1034 (Copeland), April, 1904, and Nos. 292, 382, (De Vore and Hoover), May, 1903. A shrub 1 to 2 m. high, growing at an altitude of from 2,500 m. to the summit of the mountain, 3,100 m.

MINDANAO, Davao Province, Mount Apo, *Copeland 4139* (M, W), *Copeland 1034* (M), *De Vore and Hoover 292* (M, W), *De Vore and Hoover 382* (M), *Williams 2681* (M, W), *Elmer 11395* (M, W), *Clemens s. n.* (C).

Elmer's field note upon this species reads as follows:

Erect and numerously branched 6 feet high shrub associated with other shrubs along the Seriban creek at 7,750 feet on Apo; leaves rigid, ascending, paler green beneath; flowers spreading, rather numerous and forming pure white and somewhat fragrant clusters. This delicately pretty species the Bagobos call "Malambago."

The leaves are extremely finely brown-punctate (not lepidote) above; moderately lepidote beneath. The bud-scales are brown, oval, 1 cm long or less, with filmy margins, truncate or emarginate at the apex. The long-cylindrical corolla-tube is sparsely lepidote without, sparsely hairy within. The filaments are not glabrous but sparsely hairy. The ovary, in typical material, is clothed with a white pubescence; in some specimens the pubescence is scant or absent, and the ovary is conspicuously lepidote. I have seen fruits only after dehiscence; they are typical *Vireya* fruits, 1 to 2 cm long, the placentæ tearing completely loose from the central column, the seeds long-tailed at both ends.

This species is very close to *R. jasminiflorum* Hooker f., described from the Malay Peninsula, and reported also from Borneo and other islands of the Malay Archipelago; a species which, so far as I can learn, shows the same variability in the surface of the ovary. Hooker's species has shorter, broader, more definitely sessile leaves than *R. copelandi.*

With these species one may associate the Bornean *R. gracile* Low and *R. orbiculatum* Ridley and the New Guinean *R. bodenii* Wernham. The boundary between this group and the following is not sharp; the present group is perhaps the more primitive. The flowers resemble superficially those of *R. klossii* Ridley, of the Malay Peninsula; but I doubt the existence of a close connection. In their tubular and lepidote character they suggest a direct connection to section *Lepipherum.*

Subsection 4. EUVIREYA

Leaves large, herbaceous, often acuminate. Corolla large, with a short broad tube and flaring limb. Filaments filiform, pubescent or glabrous. Anthers obovate, often with minute appendages at the base. Ovary pubescent or sparsely lepidote, large, the style columnar, the stigma as broad as the ovary. Fruits about 3 cm long, seeds with long filiform appendages. The type species of the subsection as of the section is *R. javanicum* (Bl.) Benn., described from Java and reported also from Borneo, Sumatra, and the Malay Peninsula.

10. RHODODENDRON KOCHII Stein.

Rhododendron kochii STEIN in Verhandl. schles. Gesellsch. vaterländ. Cultur Breslau 1883 (non vidi); Gartenflora 34 (1885) 193, t. 1195; ELMER in Leafl. Philip. Bot. 3 (1911) 1105; MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 41; Philip. Journ. Sci. 3 (1908) Bot. 380; Enum. Philip. Fl. Pl. 3 (1923) 168; MILLAIS, Rhodod. (1917) 199, 2d ser. (1924) 168; VIDAL, Rev. Pl. Vasc. Filip. (1886) 172.

Rhododendron sp. (affine al *Rh. javanicum* Bennett) VIDAL, Sinopsis Atlas (1883) 30, t. 60, f. F.

Rhododendron javanicum F.-VILLAR, Novis. App. (1883) 353; VIDAL, Rev. Pl. Vasc. Filip. (1886) 170, non Bennett.

Rhododendron schadenbergii MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 41, pro parte, non Warburg.

Stein's description in Gartenflora is as follows:

Baumartiger Strauch, reich verästet, die jungere Aezte glatt braunrindig. Blätter zerstreut, kursgestielt, an den blüthentragenden Astspitzen fast quirlartig dedrängt, lederig, oben glänzend dunkelgrün unten hell gelbgrün, spärlich grubig braun punktirt, ei-elliptisch, zugespitzt, ganzrandig oder verloren bogig-wellig mit leicht zurückgekrümmten Rande. Blüthen in reichblumigen Doldensträussen, gestielt, Stiele weiss schuppig, kelch sehr klein, nur als fünfeckige, flache Scheibe entwickelt, Blumenröhre kangcylindrisch, an der Basis den Kelch breit sackig überragend, oben in einen breit-tellerförmig offenen 5-spaltigen Saum ausgebreitet, Saumlappen eirund bis fast kreisrund, rein weiss, Blumenröhre aussen verloren weissschuppig. Staubfäden zu fünf, lang vortretend, mit grissen querhangenden Antheren. Griffel lang-fadig, mit kopfförmiger, grüner narbe. Frucht ? ?

Am Flusse Siriban auf-Sud-Mindanao (Philippinen) bei 2000 m als baumartige Gebüsche fast Wälder bilden von Dr. Schadenberg im Februar 1882 reich blühend gesammelt.

Wir haben schon auf Seite 5 deises Jahrganges auf die pflanzengeographische Bedeutung der Auffindung dieses Rhododendron und des nachfolgenden Rhododendron Apoanum Stein hingewiesen, weil durch diesen Fund dis Verbindungslinie der Rhododendra der centralâsiatischen Hochgebirge mit den von Ferdinand von Müller auf den Papua-Inseln und Neu-Guinea entdeckten Alpenrosen fast vollständig hergestellt wird. Die Hochgebirge dieser einzelnen Inselgruppen schienen reich an endemishen arten su sein, welche flüchtige Betrachtung wohl mit den Festlandsarten zusammenwerfen lässt, die aber bei genauerem Hinsehen sich als wesentlich verschiedene selbstständige Arten erweisen. So steht Rh. Kochii gewissen Himalaya-Arten habituell nahe, speciell dem Rh. jasminiflorum Hook. aus dem Sikkim, weicht aber in den einzelnen, Charakteren, z. B. der Kelchbildung, der Form der Blumenkronlappen und der Blätter erheblich ab.

Dr. Schatenberg, welchem wir reichliches Blüthenmaterial dieser schönen Art verdanken, welche er gemeinsam mit seinem auf Cebu (Philippinen) ansässigen Vetter O. Koch am Siriban sammelte, schildert den Totaleindruck der blüthenüberschütteten Sträucher als einen gradezu überwältigenden. Sie treten hauptsächlich als unterholz der Wälder auf, welche von mächtigen Myrtaceen, besenders Leptospermum (Glaphyria) Annae gebilded sind, stellenweis aber sind sie auf Waldblossen und an den Flussläufen

geradezu selbst waldbildend. Diese Gebüsche erreichen eine Höbe bis zu 10 m und zeigen armsdicke, dunkelbraune Einzelstämme, welche sich reich verästeln und deren jüngere Zweige glatt braunrindig, mit nicht abblätternder Rinde sind. Die dick lederigen Blätter laufen plötzlich in eine meist lange, scharfe Spitze aus und messen 12-18 cm Lange und bis 5 cm Breite. Der 2-3 cm lange Blattstiel sitzt auf einem starken Blatkissen auf und setze sich als sehr starke Mittelrippe bis zur Blattspitze fort. Die aussergewohnlich stark netzadrige Unterseite des Blattes seigt eine spärliche Uberstreuung mit dunkelbraunen punktförmigen schüppchen. Bluthen zu 10-20 auf 2,2,5 cm langen weiss schuppigen Stielen, welche sich in einem 2–3 mm! breiten flach- plattenartigen, fünfechkigen Kelch verbreiten, dessen fünf Ecken als kleine rundliche Läppchen vortreten. Die weisse, schuppenbekleidete Blumenröhre von 3–5 cm Länge tritt sackig über den Kelch heraus, ist fast cylindrisch und öffnet sich in einen schneeweissen Teller von 3–4 cm Durchmesser. Fruchexemplare liegen uns nicht vor, doch sind Abweichungen von der normalen Kapselform nach der Bildung des Fruchtknotens in unseren Bluthen nicht wahrscheinlich.

Wir haben bereits darauf hingewiesen, dass Rhod. Kochii es ausserordentlich verdiene in unsere Culturen eingeführt zu werden, und da sowohl Herr Dr. Koch, dem wir die Art widmeten, als auch Herr Dr. Schadenberg in diesem Herbste wieder nach den Philippinen zurückkehren, ist es leicht möglich, dass unser Wunsch bald Erfüllung finden wird.

MINDANAO, Davao Province, Mount Apo, *Elmer 11435* (M, W), *De Vore and Hoover 73* (M), *Mearns s. n.* (W), *Bur. Sci. 15654 Clemens* (C) : Cotabato Province, Mount Matutum, *Copeland s. n.* (M) : Misamis Province, Mount Malindang, *For. Bur. 4674 Mearns and Hutchinson* (M, W). NEGROS, Canlaon Volcano, *Merrill 7305?* (M). LUZON, Bataan Province, Mount Mariveles, *Merrill 3255* (M, W), *For. Bur. 790 Borden* (M, W), *Leiberg 6033* (M), *Whitford 450* (M, W), *For. Bur. 2117 Borden* (M, W), *Elmer 6856* (M), *Bur. Sci. 1629 Foxworthy* (M), *For. Bur. 6281 Curran* (M), *Topping 806* (M) : Laguna Province, Mount San Cristobal, *For. Bur. 28978 Canicosa* (M) ; Mount Banahao, *Whitford 958* (M, W), *Loher 6181* (M, W), *For. Bur. 7868 Curran and Merritt* (M, W), *Bur. Sci. 9834 Robinson* (M), *Bur. Sci. 19589 Ramos* (M, W), *Gates 6108* (M), *Brown s. n.* (M), *Bur. Sci. 47424 McGregor* (M, C) : Mountain Province, various localities, *For. Bur. 10961 Curran* (M, W), *Vanoverbergh 957* (M) *Clemens 732* (C), *For. Bur. 29404 Zschokke and Larava* (C).

Speaking of a part of the specimens here listed, Merrill (1908) remarks as follows:

Many of the above specimens were previously erroneously identified by me as *Rhododendron schadenbergii* Warb., from which they differ notably in the hirsute ovary. The shape of the leaves is variable, and but few

of the specimens are as prominently acuminate as shown in the original figure, and they average smaller than the measurements given in the original description. The species is described as having five stamens, but the figure apparently shows ten, the latter number agreeing with our specimens.

Elmer, referring to his specimen No. 11383, gives the following field notes:

> Tree-like shrub along the Seriban creek at 6,500 feet of mount Apo, in dense woods of moss covered soil; stem 3 to 6 inches thick, 10 to 20 feet high, usually inclining; branches ascending, rather numerously and laxly rebranched; wood soft, reddish white toward the center, without odor or taste; bark brown, smoothish; leaves in whorls, ascendingly recurved from the reddish petioles, rigidly coriaceous, dark sublucid green above, much paler or yellowish green beneath; pedicels reddish; flowers white, odorless, ascendingly spreading, white [*sic*!]; filaments whitish; anthers brownish; style and stigma greenish. "Malagus" is the name given to it by the Bagobos. If I remember correctly the natives also called the large white flowered *Drimys piperita Hook.* by the same name. One must admit casual similarity in the two species representing widely different families.

This paragraph definitely established *Elmer 11435* as a topotype, typical of the species.

The distribution of the species as shown by the specimens is rather peculiar. From the great region lying between Mindanao and Luzon, I have only one specimen, *Merrill 7305*, and that, being in fruit, not certainly identified. A careful comparison, however, of the specimens from the north with *Elmer 11435*, reveals no consistent difference, except perhaps that the plants are smaller, the average height as given on the field labels being about 3 meters.

The specimen cited by Vidal as *R. javanicum* was his number 412 from Mount Banahao. It appears not to have been in flower. *Rhododendron kochii* differs from *R. javanicum* in the color of the flowers, which, in the Javan species, are orange, and in the pubescence of the ovary; it is closer to *R. teysmanni* Miquel. Both species are common throughout the Malay region; *R. teysmanni* has slightly larger leaves and flowers than *R. kochii*, and fewer flowers in the umbel; but except for the difference in color of flowers might be regarded as the same species.

Bur. Sci. 692 Foxworthy, from Mount Victoria, Palawan, is in fruit. It is very similar, but cannot positively be identified as belonging to this species. It is the only *Rhododendron* I have seen from Palawan, and apparently is the only one that has been collected there.

11. RHODODENDRON WILLIAMSII Merrill MS. sp. nov.

Rhododendron schadenbergii MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 40, in part; Philip. Journ. Sci. 3 (1908) Bot. 380; Enum. Philip. Fl. Pl. 3 (1923) 245, non Warburg.

Merrill's manuscript description reads in part as follows:

Arbor glabra, 4 ad 6 m alta; foliis oblongo-ovatis vel oblongo-ellipticis, coriaceis, nitidis, acuminatis, 7 ad 10 cm longis; floribus albis, 2.5 ad 3.8 cm longis; staminibus 10, filamentis glabris; ovario pauce lepidoto.

A small tree 4 to 6 m high, the branches light gray or brownish, terete. Leaves oblong-ovate to oblong-elliptical, coriaceous, shinning, paler beneath, widest in the middle, narrowed above to the short but sharply cuminate apex and below to the acute base, very obscurely glandular beneath; primary nerves about 7 on each side of the midrib, somewhat ascending, not prominent, the secondary nerves and reticulations nearly as prominent; petioles 1 to 1.5 cm long. Flowers white, terminal, the peduncle stout, short, covered with large scars; pedicels 2.5 to 3 cm long, lepidote. Calyx disciform, 5-toothed. Corolla 2.5 to 3.8 cm long, glabrous, the tube 1.8 to 2.3 cm long, slightly enlarged above, the lobes orbicular or obovate, rounded, about 1 cm long. Stamens 10; filaments glabrous; anthers about 3 mm long. Ovary oblong, slightly lepidote, not at all hairy, 5 or 6 mm long; style about 2 cm long, slightly lepidote below, otherwise glabrous. . . .

This was previously identified by me as *Rhododendron schadenbergii* Warb., but judging from Warburg's description it is not the same as that species. . . .

Rhododendron williamsii is very similar to *R. kochii* in gross and superficial characters, but is at once distinguishable by its ovary being only slightly lepidote, while in *R. kochii* the ovary is densely hirsute or pilose.

LUZON, Mountain Province, Benguet Subprovince, Baguio, *Elmer 6519* (M, W, type of the species), *Merrill 1750* (M), *Sandkuhl 132* (M); Mount Santo Tomas, *Williams 990, 1348* (M, W), *Bur. Sci. 5392 Ramos* (M); Tabio, *Loher 3763* (W): Lepanto Subprovince, Mount Data, *Bur. Sci. 40189 Ramos and Edaño* (M): Bontoc Subprovince, Mount Pukis, *Bur. Sci. 37773 Ramos and Edaño* (M, W): Zambales Province, Mount Pinatubo, *Clemens 1743* (C).

The fruits are dark oblong capsules, 15 to 25 mm long and about 5 to 7 mm thick, bearing the persistent style which is about 25 mm long. The dehiscence is characteristic of the subgenus *Vireya*, the soft exocarp first peeling off, after which the five valves separate at the summit and become recurved. The minute seeds bear at both ends appendages much longer than themselves.

This species is very close to *R. kochii;* it is not close to the *R. xanthopetalum* group, in whose neighborhood my artificial key, based on the pubescence of the floral parts, places it.

12. RHODODENDRON MINDANAENSE Merrill.

Rhododendron mindanaense MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 41; Philip. Journ. Sci. 3 (1908) Bot. 381; Enum. Philip. Fl. Pl. 3 (1923) 244; ELMER in Leafl. Philip. Bot. 3 (1911) 1106; MILLAIS, Rhodod. (1917) 210, 2d ser. (1924) 188.

The original description is as follows:

A shrub about 1 m. high, with glabrous, coriaceous, oblong-ovate obtuse leaves, the white flowers 4 to 4.5 cm. long, crowded in fascicles at the apices of the branches. Branches reddish or somewhat grayish, the ultimate branchlets sparingly lepidote. Leaves crowded at the upper nodes and at the apices of the branchlets, 5 to 7 cm. long, 2 to 3.5 cm. wide, tapering below to the cuneate base, the apex obtuse, often slightly emarginate, beneath with few scattered, obscure glands; petioles about 1 cm. long, sparingly lepidote. Flowers many, the peduncles 2 cm. long, lepidote, the deciduous bracts 2 to 3 cm. long. Calyx reduced to an obscure disk. Corolla 4 to 4.5 cm. long, narrowly campanulate, the tube 2.5 cm. long, 5 mm. in diameter below, very slightly enlarged above, the lim 3 to 3.5 cm. in diameter, 5-lobed, the lobes erect-spreading, obovate, obtuse, 2 cm. long. Stamens 10, the filaments pubescent below, glabrous above, 2.5 cm. long, the anthers 3 mm. long. Ovary densely yellowish brown pubescent, 6 mm. long. Style pubescent below, glabrous above, 2 cm. long.

Type specimen No. 1042 (Copeland), Mt. Apo, District of Davao, Mindanao, April, 1904; also No. 73 (De Vore and Hoover), same locality, May, 1903, erroneously localized as from the Island of Basilan. A shrub growing at the summit of the mountain at an altitude of 3,100 m. above the sea.

Specimens examined (representing all known collections): MINDANAO, Davao Province, Mount Apo, *Copeland 1042* (M), *Mearns s. n.* (W), *De Vore and Hoover 73* (M), *Elmer 11383* (M, W).

Elmer gives the following field notes:

A stunted erect shrub, 3 feet high, scattered with other dwarfed shrubs about the summit of mount Apo at 9,950 feet; stems erect, few to several, sparingly branched; leaves rigidly coriaceous, copiously arranged in subwhorls, ascending, paler green beneath; flowers pure white, rather large and showy, ascendingly scattered. The Bagobos call it "Malagus."

The fruits, numerous in each cluster, are massive, fusiform, slightly curved, warty and pilose, about 3.5 cm long, on stout pedicels of equal length. Each one has five lengthwise grooves. The dehiscence is probably exactly like that of *R. kochii.*

The species is fairly close to *R. kochii* and *R. teysmanni,* differing in the smaller stature and rounded leaves, and in the massiveness of the fruits and other parts. The anthers are minutely appendaged at the base.

13. RHODODENDRON BRACHYGYNUM sp. nov.

Frutex 1 m altus, floribus flavis. Rami in sicco fusco-rufi. Folia aut dispersa, aut in apicibus ramulorum congregata, ovalia, supra lucida, minutissime nigro-punctata, subtus modice pallide lepidota, ca. 10 cm longa, 4.5 cm lata, apice breviter acuminata, basi obtusa, in petiolum 1.5 cm longum decurrentia. Flores ca. quini in umbellis sessilibus. Pedicelli validi, pubescentes ca. 2 cm longi. Corolla flava, anguste obconica, ca. 4 cm longa; lobis 5, rotundis, ca. 1.5 cm longis. Stamina 10, filamentis ca. 3 cm longis, in parte inferiore minute pubescentibus; antheris oblongis, 3 mm longis, basi minute appendiculatis. Pistillum 1.6 mm longum, dimidio inferiore pubescente; ovario anguste conico, 8 mm longo; stigmate 2 mm lato. Gemmae fructusque ignoti.

CEBU, Sudlon, *For. Bur. 28346 Cenabre and De la Cruz* (M).

This species, known to me by a single specimen which was perhaps the only one collected, shows very interesting relationships. It is very close to *R. teysmanni* Miquel and to *R. kochii*. The leaves, which are very similar in all three species, are smaller in *R. kochii* than in the others. *Rhododendron brachygynum* differs from *R. kochii* in having yellow flowers; those of *R. teysmanni* are also yellow. The appendages on the anthers are shared by *R. teysmanni* and, if not by *R. kockii*, at least by its close relative *R. mindanaense*. On the other hand, this species represents a transition from the ones just mentioned to *R. leytense* and *R. loheri*, which share the yellow flowers and appendaged anthers, but have somewhat smaller leaves, not at all acuminate, and drying to a dark brown color. All the species here mentioned are alike in the pubescence on the ovary and filaments. *Rhododendron brachygynum* differs from all the others in the fact that the pistil is only about half as long as the stamens.

14. RHODODENDRON LEYTENSE Merrill.

Rhododendron leytense MERRILL in Philip. Journ. Sci. 10 (1915) Bot. 55; Enum. Philip. Fl. Pl. 3 (1923) 244.

The original description is as follows:

Frutex epiphyticus, subglaber, ramis ramulisque teretibus; foliis coriaceis, alternis vel subverticillatis, oblongis vel oblongo-ellipticis, usque ad 7 cm longis, utrinque angustatis acutisque, supra nitidis, subtus lepidotis, nervis lateralibus utrinque circiter 8, tenuibus, obscuris; floribus terminalibus, in umbellis sessilibus dispositis, bracteis involucrantibus caducis, oblongis, acuminatis, circiter 2.5 cm longis; corolla flava, 4 cm longa, late tubuloso-campanulata.

An epiphytic, nearly glabrous shrub, the branches and branchlets terete, grayish or reddish-brown, smooth, the ultimate ones about 2.5 mm in diameter. Leaves alternate or subverticillate, coriaceous, oblong to oblong-elliptic, 4 to 7 cm long, 1.5 to 3 cm wide, subequally narrowed to both the acute base and apex, or the base sometimes a little decurrent-acuminate, brownish when dry, the upper surface glabrous, shining, the lower somewhat paler, and with numerous, but not densely arranged, brown lepidote scales; lateral nerves slender, obscure, about 8 on each side of the midrib; petioles 1 to 1.5 cm long. Inflorescence terminal, the flowers in sessile umbels, in bud quite enclosed by imbricate bracts, the bracts caducous, brown when dry, glabrous, shining, oblong, acuminate, about 2.5 cm long, the bracteoles narrow. Flowers yellow, usually 4 or 5 in each umbel, their pedicels pubescent, about 1 cm long in anthesis, twice as long in young fruit. Calyx obsolete, represented by a mere thickening of the apex of the pedicel. Corolla broadly tubular-campanulate, yellow, about 4 cm long, the tube broad, about 2 cm long, the lobes broadly elliptic to obovate, rounded, 1.3 to 1.5 cm wide. Stamens 9 or 10, the filaments slender, a little unequal; anthers oblong, obtuse, 3 mm long. Ovary rather densely pubescent, cylindric, elongated, narrowed upward into the style which is pubescent below and glabrous above; stigma with 5, stout, broad, obtuse lobes.

LEYTE, Mount Ibuni, back of Dagami, *Bur. Sci. 15252 Ramos*, August 23, 1912, growing in the tops of trees.

A rather characteristic species, among the Philippine forms perhaps most closely allied to *Rhododendron kochii* Stein, although entirely different from that species in many details of its leaves, and in the color and character of its flowers.

The stamens are sparsely pubescent near the base.

This species is known only by the type collection. I have seen the specimens of the herbarium of the Bureau of Science at Manila, and of the United States National Herbarium.

15. RHODODENDRON LOHERI sp. nov.

Arbustus, floribus pallide flavis. Folia ovalia, 4 ad 8 cm longa, superne nuda, rugulosa, subtus modice lepidota, apice obtusa, basi obtusa, in petiolum 1 cm longum decurrentia. Flores ca. quini in umbellis terminalibus. Pedicelli crassi, puberulentes, 2 ad 3 cm longi. Calyx disciformis. Corolla anguste obconica, circa 3 cm longa, pallide flava, minus quam 1 cm longa. Stamina 10, filamentis ca. 2 cm longis, in parte infima minute pubescentibus, antheribus ca. 2.5 cm longis, basi minute appendiculatis. Pistillum ca. 2.5 cm longum, dimidio inferiore pubescente; ovario anguste conico, 10 mm longo; stigmate 2.5 mm lato. Gemmae fructusque inogti.

LUZON, Rizal Province, Guinuisan, *Loher 14769* (M, C).

This species, known by a single collection from the poorly explored mountainous region some distance east of Manila, is very close to *R. leytense;* the leaves, which are broadly elliptic, brown when dry, and besprinkled on the lower surface with

pale scales, are indistinguishable from those of Merrill's species. The separation is based on the slightly smaller corolla, which is of firmer texture; the smaller pistil, which equals the stamens; and the minute appendages at the base of the pollen sacs.

The relationships of the Philippine *Euvireyas* have, I think, been sufficiently discussed under *R. brachygynum*. With them, and with *R. javanicum* (Blume) Bennett and *R. teysmanni* Miquel, both of which occur in the Malay Peninsula and Archipelago, one associates the Bornean *R. kinabaluense* Merrill and *R. obscurinervium* Merrill and the New Guinean *R. zoelleri* Warburg.

Subsection 5. LEOIVIREYA

Epiphytes; leaves leathery to fleshy, usually not acuminate; flowers large, usually colored; the filaments usually pubescent, the anthers large, linear, without appendages; ovary glabrous to moderately lepidote; style columnar, stigma capitate. The type is *R. crassifolium* Stapf.

16. RHODODENDRON CLEMENTIS Merrill.

Rhododendron clementis MERRILL in Philip. Journ. Sci. 3 (1908) Bot. 160, 381; Enum. Philip. Fl. Pl. 3 (1923) 243; MILLAIS, Rhodod. 2d ser. (1924) 113.

The original description is as follows:

Arbor glabra; foliis subcoriaceis, elliptico-oblongis, obtusis, usque ad 16 cm longis, nitidis, subtus squamulis parvis notatis; floribus aurantiacis, 4.5 ad 5 cm longis latisque, glabris; staminibus 10, in parte inferiore plus minus pubescentibus; ovario oblongo, glabro, 5-loculari.

A tree, the branches terete, reddish-brown or grayish, the younger ones dark-reddish-brown, glabrous. Leaves elliptical-oblong, 9 to 16 cm long, 4.5 to 8 cm wide, subcoriaceous, shining, somewhat paler beneath, entirely glabrous above, beneath with numerous scattered small lepidote glands, the base acute, the apex usually broad, rounded, rarely subacute or obscurely acuminate; nerves about 10 on each side of the midrib, not prominent, somewhat ascending, reticulating; petioles stout, 1 to 1.5 cm long. Flowers orange-colored, 5 to 10 or more at the apices of the branches on a short stout rachis, the buds covered by numerous membranous, shining, deciduous, elliptical bracts about 3 cm long, forming ellipsoid heads 3 to 3.5 cm long; pedicels glabrous, 2 to 3 cm long. Calyx disciform, 5-toothed. Corolla glabrous, 4.5 to 5 cm long and wide, the tube about 2 cm long, somewhat broadened upwards, the lobes 2.5 cm long, 2 cm wide, elliptical-obovate, rounded. Stamens 10; filaments 2.5 to 2.8 cm long, more or less pilose below, glabrous above; anthers 5.5 to 7 mm long. Ovary oblong, glabrous, 5 mm long, 5-celled; style glabrous, 1 cm long; stigma capitate, 2 mm in diameter. Immature fruit glabrous.

MINDANAO, Lake Lanao, Camp Keithley, *Mrs. Clemens 732*, October, 1906, also without numbers, November, 1906, and October, 1907.

A species characterized by its orange flowers, oblong-elliptical obtuse leaves, which are but slightly lepidote beneath, its glabrous ovaries, etc.

MINDANAO, Lanao Province, Camp Keithley, *Clemens 732* (M, W), also several unnumbered sheets; Camp Vicars, *For. Bur. 25221 Alvarez?*, in fruit (M, W): Zamboanga Province, Sax River Mountains, *Merrill 8136* (M). JOLO, *Clemens 9398, 9399* (M).

Rhododendron clementis is no tree, but an epiphyte. Under this name are included specimens with strictly glabrous, rather bulky, ovaries, the basal disk and calyx being but slightly wider than the ovary, the disk crowned with white hairs. The corolla is orange in the type material and in the specimens from Jolo, which differ only in that all parts, leaves, buds, and flowers, are larger. Alvarez's specimen, from Lanao, in fruit, has narrow leaves, and may, very likely, be referable to *R. spectabile*. *Merrill 8136* has red flowers, and seems to be intermediate between this species and *R. spectabile*.

17. RHODODENDRON SPECTABILE Merrill.

Rhododendron spectabile MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 42; Philip. Journ. Sci. 3 (1908) Bot. 381; Enum. Philip. Fl. Pl. 3 (1923) 245; ELMER in Leafl. Philip. Bot. 3 (1911) 1106; MILLAIS, Rhodod. (1917) 246, 2d ser. (1925) 241.

The original description reads as follows:

A glabrous shrub about 1 m. high, with coriaceous, elliptical-ovate to elliptical-oblong, scattered, alternate, acuminate or merely acute leaves, and large, red odorless flowers, 5 to 5.5 cm. long, in terminal 3-flowered fascicles. Branches glabrous, the ultimate ones reddish brown. Leaves 7 to 9 cm. long, 3.5 to 4.5 cm. wide, glabrous above, glandular-punctate beneath, the base acute or somewhat rounded, the midrib very prominent; petioles very stout, 1 to 1.5 cm. long. Peduncles glabrous, 2.5 cm. long. Calyx reduced to an obscure disk. Corolla campanulate, the tube 2 cm. long, 6 mm. in diameter below, the limb spreading, 5 to 6 cm. in diameter, 5-lobed, the lobes 2.5 cm. long, elliptical-ovate, rounded. Stamens 10, the filaments sparingly pubescent below, 2.5 cm. long, the anthers 5 mm. long. Ovary glabrous, oblong, 8 mm. long; style glabrous, 2.5 cm. long.

Type specimen No. 1438 (Copeland), Mount Apo, District of Davao, Mindanao, October, 1904; also No. 369 (in part) (De Vore and Hoover), same locality, May, 1908. A shrub growing in ravines at an altitude of 2,500 m., apparently closely related to *Rhododendron javanicum* Blume.

MINDANAO, Davao Province, Mount Apo, *Copeland 1438* (M, W), *De Vore and Hoover 369* (M), *Mearns*, three unnumbered sheets (W), *Elmer 10631* (W). CAMIGUIN DE MISAMIS, Camiguin Volcano, *Bur. Sci. 14599 Ramos* (M).

Elmer's field note on this species reads as follows:

An epiphyte in moss covered dry woods on a ridge 7,500 feet of mount Calelan; stems few, spreading, subdeflexed, the tips suberect and green; twigs rather gnarly, ashy gray; leaves thickly coriaceous, dull dark green on the upper side, gradually recurved, much lighter green and punctate

beneath; flowers divaricate, not numerously clustered, very showy, odorless, pedicels thick, terete, ascending, reddish; corolla heavy and somewhat fleshy, 2 to 3 inches long, purple red, the rotate lobes as widely spreading as the flower is long; stamens and pistil pale red; ovary glabrous, reddish brown; anthers creamy yellow. "Malagas" is the native Bagobo name.

Represented by number 10631, *Elmer*, Todaya (mt. Apo), Mindanao, May, 1909.

To this species are assigned specimens with rather narrow leaves scattered along the branches. The flowers are red, large, few in the cluster; the ovary is rather slender, the disk almost glabrous, the calyx about twice as broad as the base of the ovary.

Field notes are scarce. The type was apparently a terrestrial plant. Mearns's specimens (two of them apparently from the same plant) have rather longer leaves than the type. Elmer's specimen has decidedly broader leaves than the type, and was an epiphyte; as the above-quoted note shows, it was not from Apo proper, but from the neighboring Mount Calelan. The specimen from Camiguin de Misamis is geographically incongruous. It has smaller flowers than the type, and they are described as "rose champaca," which probably means brownish pink; nevertheless the specimen appears to belong to this species.

18. RHODODENDRON XANTHOPETALUM Merrill.

Rhododendron xanthopetalum MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 41; Philip. Journ. Sci. 1 (1906) Suppl. 111, 3 (1908) Bot. 380; Enum. Philip. Fl. Pl. 3 (1923) 246; MILLAIS, Rhodod. (1917) 263, 2d ser. (1924) 261.

The original description reads as follows:

A glabrous epiphytic shrub, 80 cm. or less high, with a stout, simple or but slightly branched stem, coriaceous, scattered, alternate, slightly acuminate or merely acute, oblong-elliptical leaves, the flowers yellow, 3 cm. long, 3 or 4 in a terminal fascicle. Stem 1 cm. in diameter below, the bark light gray, glabrous, the younger parts reddish brown. Leaves 9 to 12 cm. long, 3.5 to 5 cm. wide, the base acute, the upper surface glabrous, the lower surface somewhat paler, glandular-punctate, the margins revolute, the midrib very stout and prominent; petioles very stout, 1.5 cm long. Peduncles glabrous, 1.5 cm. long. Calyx reduced to an obscure disk. Corolla 5-lobed, campanulate, 3 to 3.4 cm. long and about as wide, the tube 1.5 cm. long, 5 mm. in diameter below, the lobes 1.5 cm. long, rounded. Stamens 10, the filaments pubescent bellow, 18 mm. long, the anthers 4 mm long. Ovary 8 mm. long, lepidote, 5-celled style 12 mm. long, glabrous.

Type specimen No. 322 (Whitford), Mount Mariveles, Province of Bataan, Luzon, May, 1904. A small shrub growing on mossy tree trunks at an altitude of 1,200 m. Apparently rare, as only a single specimen was found.

LUZON, Bataan Province, Mount Mariveles, *Whitford 322* (M), *For. Bur. 6279 Curran* (M): Rizal Province, Montalban,

Loher s. n. (C): Nueva Vizcaya Province, Carballo Sur Mountains, *Loher, s. n.* (C) MINDORO, Ibolo, *For. Bur. 11429 Merritt.*

This species remains "apparently rare." It is definitely marked by the rather small lepidote ovary, which is totally without pubescence, although a few hairs occur on top of the disk which surrounds the base of the ovary. The calyx is much broader than the base of the ovary. I have little confidence in the identification of the specimen from Mindoro; it is in poor condition, and might better, perhaps, be assigned to *R. clementis.*

19. RHODODENDRON SCHADENBERGII Warburg.

Rhododendron schadenbergii WARBURG in Perkins Frag. Fl. Philip. (1905) 172; MERRILL in Philip. Journ. Sci. 3 (1908) Bot. 380, in part; MILLAIS, Rhodod. (1917) 239, 2d ser. (1924) 230.

The original description is as follows:

Ramis teretibus glabris, petiolis crassis foliis crasse coriaceis oblongis basi et apice acutis supra glabris subtus squamulis inspersis, venis utrinque 6–12 semipatentibus apice curvatis supra prominulis subtus vix distinctis, interspersis interdum minoribus subparallelis, nervis tertiariis haud vel vix perspicuis. Inflorescentia terminali, pedunculo brevissimo valdo crasso bractearum cicatricibus obtecto, pedicellis subumbellate dispositis longis quam flores brevioribus glabris, apice bracteolam membranaceam glabram lanceolatam vel lineari-lanceolatam gerentibus, calyce disciformi 5-angulato, disco annuliformi 10-nodoso, corolla glabra infundibuliformi campanulata ad medium fere 5-lobata, lobis apice rotundatis haud emarginatis, staminibus 10 filamentis in parte superiore pilosis, antheris magnis crassis oblongis, ovario glabro oblongo, stylo crasso quam ovarium longiore apice disco lato stigmatifero capitato.

Die Blattstiele sind 1½ cm lang, 3 mm dick, die Blätter sind 8–11 cm lang, 2½–4 cm breit, die grösste Breite liegt in der Mitte, von wo sie sich nach beiden Seiten hin langsam verschmälern, nach der Basis zu langsam in der Blattstiel auslaufend, oberseits eine nicht abgespitzte Spitze bildend. Die gemeinsame Blütenstandstiel ist 8 mm lang und 10 mm breit, die einzelnen Bracteennarben sind 1 mm hoch und 8 mm breit, die Blütonstielchen sind 2½ cm lang, 1½ mm dick, die Bracteole an der Spitze derselben ist ½–1½ cm lang, und unten ca. 2 mm breit, der fünfeckige Kelch ist 5 mm breit und hat eine Höhe von 1 mm, die Corolla ist 3½–4 cm lang, die einzelnen Lappen derselben sind 1½–2 cm lang und fast ebenso breit, die Stanbgefässe sind 2½ cm lang, am unteren ende fast 1 mm breit, grau behaart; die Antheren sind 4 mm lang, 1¼–1½ mm breit; das Ovar ist 8–10 mm lang, 3½ mm breit, der Griffel ist 12–15 mm lang, ¾–1 mm breit, kahl, und entweitert sich oben zu einer 3 mm breiten Scheibe.

LUZON Isl., Prov. Abra, 1300 m. s. m. (SCHADENBERG).

Diese sehr schöne neue Art, deren Farbe leider in dem mir von dem Sammler freundigst mittgeteilten Alkoholmaterial nicht mehr erkennbar war, steht dem *Rh. javanicum* und *Teysmanni* am nächsten, die dickere lederartige Konsistenz der nicht zugespitzten unten zerstreut mit Schuppen besetzten Blätter das viel grösser ganz kahle Ovar, der dickere kahle Griffel, die längeren Antheren sind die Hauptunterchiede.

I regard the following specimens as representative:

LUZON, Mountain Province, Bontoc Subprovince, Tinglayan, *For. Bur. 10989 Curran* (M, W): Ifugao Subprovince, Mount Polis, *Bur. Sci. 19654 McGregor* (M).

Ignorance of the color of the flowers delayed the recognition of this species for more than twenty years. With regard to the type of *R. schadenbergii,* Merrill [8] remarks:

> The type, which I have seen in the Berlin Herbarium, is in very poor condition, having been dried out from alcoholic material, and consequently much shriveled, so that an examination of it was very unsatisfactory: consequently my conception of the species has been based largely on the elaborate original description . . . Most of the specimens previously referred by me to this species are, I believe, referable to *Rhododendron kochii* Stein.

Under these conditions Merrill took *Williams 990* and *1348,* and *Elmer 6519,* (typical of *R. williamsii,* published above) as representing Warburg's species. The following table compares the original description with *R. williamsii* and with the specimens cited above:

	R. schadenbergii (original description).	*Williams 990, 1348; Elmer 6519.*	*For. Bur. 10989 Curran; B. S. 19654 McGregor.*
Petioles.....mm...	1.5 by 3.....	15–20 by 1–3.....	8–17 by 3–4.
Leaves, size...do....	80–110 by 25–40.....	80–110 by 30–60.....	8–12 by 3–5.
Leaves, shape.....	Oblong, acute at both ends; decurrent at base; sharp, not acuminate.	Oval; base blunt, decurrent; apex acuminate!	Oval to elliptic, base blunt, scarcely decurrent; apex acute, usually not acuminate.
Veins on each side of the midrib.	6–12.....	6–12.....	6–12.
Surface.....	Glabrous above, sparsely lepidote beneath.	Glabrous above, sparsely lepidote beneath.	Glabrous above, sparsely lepidote beneath.
Texture.....	"Crasse coriaceis;" "dickere lederartige."	Herbaceous.....	Thick, fleshy.
Peduncle.....mm..	8 by 11.....	10 by 4.....	7–15 by 7–10.
Bract scars....do....	1 by 8.....	1 by 4.....	1 by 8.
Pedicels.....	Shorter than the flowers; 25 mm long; fleshy; glabrous.	Equaling the flowers; 25–30 mm long; woody; lepidote.	Shorter than the flowers; 20 mm long; fleshy; glabrous.
Calyx, width...do....	5.....	5.....	5.
Corolla, length...cm..	3.5–4.....	2–4.....	3–4.5.
Corolla,lobes,length do	1.5–2.....	1–1.5.....	1.5–2.
Filaments.....	2.5 cm long, gray hairy (above?)	2.3 cm long, glabrous!	2.5 cm long, gray hairy at base!
Ovary.....	8–10 mm long, glabrous	8–10 mm long, lepidote.	8 mm long, glabrous.
Style, length....mm..	12–15.....	20.....	12–16.
Stigma, diameter do..	3.....	3.....	4.

[8] Philip. Journ. Sci. 3 (1908) Bot. 380.

Curran's collection and McGregor's appear to agree with Warburg's description in every significant respect except for the position of the pubescence on the filaments. However, "filamentis in parte superiore pilosis" describes no known Philippine *Rhododendron,* and I take the statement to be an error.

The plant is a small woody shrub with showy salmon-pink flowers. It belongs in the circle of relationship of *Rhododendron xanthopetalum,* having colored flowers, the ovary quite without hairiness, and the filaments hairy in the lower part. It is distinguished from its close relatives by the peculiar shade of the flowers and by the massive ovary and short style, which, with the disk, are totally devoid of hairs or scales. It is apparently quite rare, since the continual botanical activity in the Philippines in the past twenty years has brought in only two valid collections.

20. RHODODENDRON LOBOENSE sp. nov.

Fruticulus epiphyticus 30 ad 40 cm altus, foliis crassis, floribus flavis, magnitudinis mediocris, stricte glabris. Rami glabri, rugulosi, griseo-brunnei, minus quam 1 cm in diametro. Folia dispersa, in senectute recurvia, crassa, elliptica, basi et apice obtusa, 11 ad 12 cm longa, 5 ad 6 cm lata; marginibus leviter recurvis; venis utrinque ca. 15, apertis; petiolis crassis, 1 ad 1.5 cm longis. Gemmae ignotae. Flores ca. quini in umbellis sessilibus; pedicellis validis, 1 ad 1.5 cm longis. Calyx vix evidente. Discus prominens, 10-lobatus, stricte glaber, quam ovario duplo latiore. Corolla flava, intus et extus glabra, 3.5 ad 4 cm longa, lobis 5 inaequalibus, ovalibus, ca. 2 cm longis. Stamina 10, filamentis stricte glabris, 2.5 cm longis; antheris oblongis, 4 mm longis. Pistillum 2 cm longum, glabrum, ovario elliptico, 7 mm longo, stigmate 3 mm lato. Fructus 4 cm longus, pedicello 1.5 ad 2 cm longo, valvis 5 in dehiscentia recurvis. Semina fulva, fusiformia, minus quam 1 mm longa, utrinque appendiculata; appendiculis filiformibus, 3 mm longis.

LUZON, Batangas Province, Lobo Mountains, *For. Bur. 28045 Mabesa* (M).

This species, known by a single specimen, is characterized by the strictly glabrous flower parts. The colored flowers, thick leaves, and bulky ovaries lead me to list it with the relatives of *R. clementis,* and not close to *R. williamsii,* which shares the nakedness of ovary, disk, and filaments.

The above five species constitute a very natural group, especially well developed in Borneo; *R. crassifolium* Stapf, of British

North Borneo, has the same fleshy leaves and glabrous ovaries, but the flowers are white or pink. Other related species are *R. brevitubum* J. J. Smith, *R. crassinervium* Ridley, *R. moultonii* Ridley, and *R. murudense* Merrill. *Rhododendron brookeanum* Low and *R. lowii* Hooker f. are also very similar, but have pubescent ovaries; they appear to represent the evolutionary transition from section *Euvireya*. I have taken *R. clementis* as the most primitive of the Philippine species because it extends nearest to Borneo, and because it retains slightly more pubescence about the ovary than the others.

J. J. Smith [9] concludes his discussion of the relationships of *R. brevitubum* with the remark: "Vielleicht werden mehrere dieser Arten bei Vergleichung von nehr Material sich nur als Varietäten erweisen." This applies to the Philippine species. They are variable and they intergrade; they are collected but rarely, and almost every collection presents distinguishing characters. The distinctions lie, however, in minor details; I have been loathe to describe new species and have listed three described by Merrill together with the previously incorrectly recognized *R. schadenbergii* and one new species which is sufficiently distinguishable.

Subgenus ANTHODENDRON Endlicher

This is the group of the azaleas, for which Wilson and Rehder, in their recent Monograph of Azaleas, have shown that it is necessary to accept Endlicher's name. It is a natural group, originally distinguished from *Rhododendron* proper by deciduous foliage and flowers with five stamens instead of ten. It is a large group (with 51 species listed by Wilson and Rehder) and widely distributed; as at present limited it is very hard to define by description. Of the four sections into which Wilson and Rehder divide it, only one is represented in the Philippines.

Section TSUSUTSI G. Don

Shoots beset with flattened reddish hairs, occasionally also with spreading soft hairs. Stamens 5 or 10. Ovary beset with hairs similar to those on the foliage, sometimes glandular. Fruit conical, the valves in dehiscence separating slightly at the apex. Seeds without appendages. There are 22 species, all in eastern Asia.

[9] Ic. Bogor. 4 (1914) 253–254.

21. RHODODENDRON SUBSESSILE Rendle.

Rhododendron subsessile RENDLE in Journ. Bot. 34 (1896) 357; MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 40; Philip. Journ. Sci. 3 (1908) Bot. 379, 5 (1910) Bot. 371; Enum. Philip. Fl. Pl. 3 (1923) 245; MILLAIS, Rhodod. (1917) 249, 2d ser. (1924) 244; WILSON and REHDER, Monograph of Azaleas (1921) 51.

Rendle's original description reads as follows:

Lignosus, ramis teretibus cum setulis brunneis apressis indutis; follis ovalibus, apice abrupte breviter et obtuse mucronatis, petiolis et facie inferiore laminæ, præcipue in venis, brunne setuliferis, facie superiore cum setulis albis induta; bracteis læte brunneis ovatis vel orbiculari-ovatis, mucronatis, flore solitario subsessile, inter minores; calyce lobis 5 subrotundis fimbriatis; corolla rosea late infundibuliforme, tubo sub-brevi lato, lobis ovatis vel ovato-oblongis, staminum filamentis in parte inferiore breviter pilosis, superne glabris; ovario 5-loculare subrotundo dense piloso, stylo flexuoso basi piloso.

Hab. North-west-central Luzon, highland of Lepanto.

The younger shoots are covered with closely-packed upwardly-directed appressed brownish bristles, which in the third season are wearing off; the shoots of the third season are 3 mm. in diameter. The leaves, which are scattered along the shoot, vary in length of lamina from 2 to 4 cm., and in breadth from 6 to 14 mm.; the petiole is from 3 to 6 mm. long. The broad bracts are 8–9 mm. long; the hairy pedical 4 mm., the calyx lobes 2–3 mm. The broad corolla-tube is 9 mm. long, 5 mm. in diameter below, and only slightly more above; the lobes are 12 mm. long, 8–9 mm. broad. The short ovary (3 mm. long) is densely covered with shiny reddish upwardly directed hairs; the uniform style is 2 cm. long, ending in a small capitate stigma.

Is near *R. ledifolium* G. Don, but is, I think, distinct; the solitary almost sessile flower is much smaller than in the Chinese-Japanese species.

LUZON, Mountain Province, Benguet Subprovince, Mount Data, fragment of the type in Herb. Mus. Brit. *Whitehead s. n.* (M), *Merrill 4606* (M, W); Mount Tonglon or Santo Tomas, *For. Bur. 922 Barnes* (M, W), *Williams, 1223, 2001* (M, W), *Elmer 5799* (M, W), *Bur. Sci. 4815 Merrill* (M, W), *For. Bur. 5032 Curran* (M), *Mearns s. n.* (M), *For. Bur. 14168 Merritt* (M), *For. Bur. 11090 Whitford* (M), *Merrill 736* (M, W), *For. Bur. 25125 Leaño* (M, W), *Clemens 4966* (C), *Bur. Sci. 15775 Clemens* (C), *Bur. Sci. 45099 Ramos and Edaño* (M, C), *Bur. Sci. 16008 McClure* (C); *Elmer 8595, 14298* (M, W), *Santos 38* (M); Pauai, or Haight's, and neighborhood, *Bur. Sci. 4690 Merrill* (M, W), *Bur. Sci. 4275 Mearns* (M), *Bur. Sci. 8420 McGregor* (M), *Bur. Sci. 13994 Santos* (M), Mount Pulog, *For. Bur. 18035 Curran et al.* (M, W), *For. Bur. 18172 Curran et al.* (M), *Clemens 5063* (C), Banguino (?), *Loher 3758* (M); Mount Bau-

dan, *Bur. Sci. 40308 Ramos and Edaño* (M, W) ; Bucao, *For. Bur. 18362 Alvarez* (M) : Ifugao Subprovince, Mount Polis, *Bur. Sci. 37708 Ramos and Edaño* (M) : Lepanto Subprovince, Banaao, *Vanoverbergh 364* (M) ; Mount Malaya, *For. Bur. 16573 Darling* (M) : Bontoc Subprovince, *Clemens 7278* (C) : Abra Province, Mount Paraga, *Bur. Sci. 7105, 7249 Ramos* (M), "Central Luzon," *Loher 3760* (W).

This is the most southerly occurring, and the only Philippine, representative of the subgenus *Anthodendron.* It belongs to the northern element in the flora of Luzon, and its nearest relatives are to be found in Formosa; it is not related to the other Philippine species of *Rhododendron,* all of which have come from the south.

From the other Philippine rhododendrons it is sharply distinguished by the subgeneric and sectional characters. The stamens bear, near the base, a few very short, blunt, unicellular, white trichomes; this character also is shared by other species of *Anthodendron.* As a typical *Anthodendron, R. subsessile* is a terrestrial shrub, commonly 1 to 3 m high, but reaching a height of 6 m, occurring in clumps or masses. It occurs in the mountains from elevations of about 1,800 m up to summits about 2,400 m high. The flowers are described on fields notes as white, pink, red, violet, or purple; they have been collected in almost every month of the year. These flowers are more often in clusters of two or three than solitary. The pedicels are not consistently as short as the original description would indicate.

From *R. mucronatum* G. Don (*R. ledifolium* G. Don), with which Rendle compares it, and from *R. oldhamii* Maximowicz, a Formosan species with which Merrill compares it, Wilson distinguishes this species by the facts that the bud scales are not viscid within; that the calyx lobes are minute; and that the style bears, at the very base, a pubescence similar to that on the leaves, bud scales, and ovary. From *R. lasiostylum* Hayata and from *R. rubropilosum* Hayata, Wilson distinguishes it only by the shape of the leaves and the color of the flowers; the latter is certainly too inconstant to be distinctive.

Var. BAUCOENSE var. nov.

Suffrutex; foliis 4 ad 15 mm longis, 2 ad 5 mm latis; floribus rubris, minus quam in species.

LUZON, Mountain Province, Lepanto Subprovince, Bauko, *Vanoverbergh 351* (M), April, 1910.

Wilson comments on this specimen as follows:

> No. 351, also from Bontoc, has very slender branches and small, elliptic, acute leaves and is very different in appearance from the other specimens. I can find no morphological differences, and it appears to be simply a condition; probably the plant from which the specimen was taken was growing in the crevice of a boulder or of a cliff.

I am rather inclined to suspect that the species bears toward this variety the relation of a gigas form. The possibility of this relationship will explain not only the specimen on which this variety is based, but also several similarly anomalous specimens of other species.

ILLUSTRATIONS

Plate 1

Figs. 1 and 2. *Rhododendron quadrasianum*, tpyical, *Robinson 6502*, leaves, natural size.
Fig. 3. *Forma marivelesense, Merrill 3215*, leaf, natural size.
4. Forma *marivelesense, Merrill 3215*, flower, × 2.
5. Forma *halconense, Merrill 5736*, leaf, natural size.
6. Forma *negrosense, Elmer 9738*, leaf, natural size.
Figs. 7 and 8. *Var. malindangense, For. Bur. 4705 Mearns and Hutchinson*, leaves, natural size.
Fig. 9. Forma *davaoense, Williams 2543*, leaf, natural size.
10. Forma *davaoense, Williams 2543*, flower, × 2.
Figs. 11 and 12. Var. *intermedium, For. Bur. 8063 Curran and Merritt*, leaves, natural size.
13, 14, and 15. Var. *rosmarinifolium, Elmer 14285*, leaves, natural size.
16 and 17. Var. *rosmarinifolium, Elmer 5798*, leaves, natural size.
Fig. 18. Var. *rosmarinifolium, Elmer 5798*, flower, × 2.
Figs. 19 and 20. Forma *pulogense, Bur. Sci. 19736 McGregor*, leaves, natural size.
Fig. 21. Forma *pulogense, Bur. Sci. 19736 McGregor*, flower, × 2.
22. Forma *pulogense, Clemens 16394*, flower, × 2.
23. Forma *pulogense, Clemens 16394*, Stamen, × 5.
24. Forma *banahaoense, Bur. Sci. 19588 Ramos*, leaf, natural size.
Figs. 25 and 26. Forma *marivelesense, Merrill 3215*, anthers, × 10.
Fig. 27. Forma *marivelesense, Loher 12418*, pistil, × 5.
28. Forma *pulogense*, fruit, × 2.
29. Forma *intermedium*, fruit, × 2.
30. *Rhododendron apoanum*, flower, × 2.
31. *Rhododendron apoanum*, stamen, × 5.
32. *Rhododendron apoanum*, anther, × 10.

Plate 2

Fig. 1. *Rhododendron apoanum*, pistil, × 5.
2. *Rhododendron nortoniae*, two umbels of type, natural size.
3. *Rhododendron nortoniae*, stamen, × 2.
4. *Rhododendron nortoniae*, pistil, × 2.
5. *Rhododendron catanduanense*, two leaves of type, natural size.
6. *Rhododendron catanduanense*, fruit, natural size.

Plate 3

Rhododendron nortoniae, foliage of type, natural size.

PLATE 4

FIG. 1. *Rhododendron bagobonum*, foliage and flower of type, natural size.
2. *Rhododendron bagobonum*, fruit, × 2.
3. *Rhododendron vidalii, Bur. Sci. 37983 Ramos and Edaño*, stamen, × 2.
4. *Rhododendron vidalii*, anther, × 5.
5. *Rhododendron whiteheadi*, leaf of type, natural size.
6. *Rhododendron whiteheadi, For. Bur. 15783 Curran and Merritt*, leaf, natural size.

FIGS. 7 and 8. *Rhododendron whiteheadi, For. Bur. 8061 Curran and Merritt*, leaves, natural size.

FIG. 9. *Rhododendron whiteheadi, Bur. Sci. 4988 Ramos and Edaño*, pistil, × 2.5.
10. *Rhododendron whiteheadi*, stamen, × 5.
11. *Rhododendron whiteheadi*, anther, × 5.

PLATE 5

Rhododendron vidalii, Bur. Sci. 37983 Ramos and Edaño, foliage and flowers, natural size.

PLATE 6

FIG. 1. *Rhododendron taxifolium*, foliage and flowers of cotype, natural size.
2. *Rhododendron taxifolium*, leaf, × 5.
3. *Rhododendron taxifolium*, stamen, × 5.
4. *Rhododendron taxifolium*, anther, × 10.
5. *Rhododendron taxifolium*, pistil, × 10.
6. *Rhododendron taxifolium*, fruit, × 2.

PLATE 7

FIG. 1. *Rhododendron copelandi, Elmer 11395*, foliage and flowers, natural size.
2. *Rhododendron copelandi, Williams 2681*, stamen, × 2.

FIGS. 3 and 4. *Rhododendron copelandi*, anthers, × 10.

FIG. 5. *Rhododendron copelandi, De Vore and Hoover 242*, pistil, × 2.
6. *Rhododendron kochii*, stamen, × 2.
7. *Rhododendron kochii*, pistil, × 2.
8. *Rhododendron williamsii*, stamen, × 2.
9. *Rhododendron williamsii*, pistil, × 2.
10. *Rhododendron mindanaense, Mearns*, stamen, × 2.5.
11. *Rhododendron mindanaense*, anther, × 5.
12. *Rhododendron mindanaense*, pistil of type, × 2.5.

PLATE 8

Rhododendron kochii, foliage and flowers, natural size.

PLATE 9

Rhododendron williamsii, foliage and flowers, natural size.

PLATE 10

Rhododendron mindanaense, Mearns, foliage and flowers, natural size.

PLATE 11

FIG. 1. *Rhododendron kochii*, fruit, × 2.
2. *Rhododendron williamsii*, fruit, × 2.
3. *Rhododendron mindanaense, Elmer 11383*, fruit, natural size.
4. *Rhododendron brachygynum*, stamen of type, × 2.
5. *Rhododendron brachygynum*, anther, × 10.
6. *Rhododendron brachygynum*, pistil, × 2.
7. *Rhododendron leytense*, stamen of type, × 2.
8. *Rhododendron leytense*, anther, × 10.
9. *Rhododendron leytense*, pistil, × 2.
10. *Rhododendron loheri*, stamen of type, × 2.
11. *Rhododendron loheri*, anther, × 10.
12. *Rhododendron loheri*, pistil, × 2.

PLATE 12

FIGS. 1 and 2. *Rhododendron clementis*, leaves of cotype, natural size.
FIG. 3. *Rhododendron clementis*, stamen, × 2.
4. *Rhododendron clementis*, pistil, × 2.
5. *Rhododendron clementis, Bur. Sci. 9399 Clemens*, stamen, × 2.
6. *Rhododendron clementis, Bur. Sci. 9399 Clemens*, pistil, × 2.

PLATE 13

FIG. 1. *Rhododendron clementis, Merrill 3186*, leaf, natural size.
2. *Rhododendron clementis, Merrill 3186*, stamen, × 2.
3. *Rhododendron clementis, Merrill 3186*, pistil, × 2.
4. *Rhododendron spectabile*, stamen of type, × 2.
5. *Rhododendron spectabile*, pistil, × 2.

PLATE 14

Rhododendron spectabile, Mearns, foliage and flowers, natural size.

PLATE 15

FIG. 1. *Rhododendron xanthopetalum*, leaf of type, natural size.
2. *Rhododendron schadenbergii, Bur. Sci. 19654 McGregor*, leaf, natural size.
3. *Rhododendron loboense*, leaf of type, natural size.

PLATE 16

FIG. 1. *Rhododendron xanthopetalum*, stamen of type, × 2.
2. *Rhododendron xanthopetalum*, pistil, × 2.
3. *Rhododendron schadenbergii, Bur. Sci. 19654 McGregor*, stamen, × 2.
4. *Rhododendron schadenbergii, Bur. Sci. 19654 McGregor*, pistil, × 2.
5. *Rhododendron loboense*, stamen of type, × 2.
6. *Rhododendron loboense*, pistil, × 2.
7. *Rhododendron subsessile*, flower, × 2.
8. *Rhododendron subsessile*, anthers, × 10.
9. *Rhododendron subsessile*, pistil, × 2.
10. *Rhododendron subsessile*, fruit, × 2.

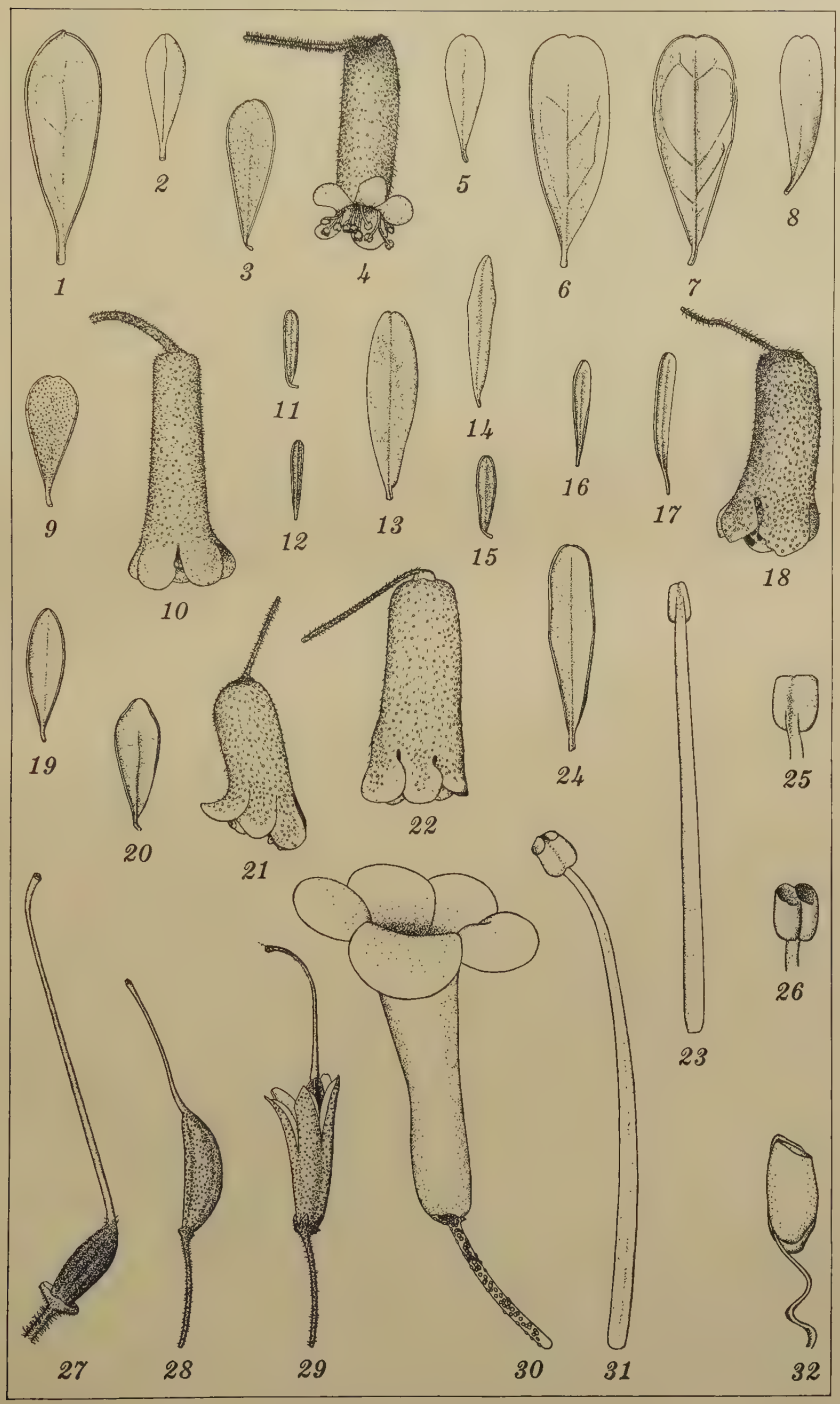
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PLATE 1.

PLATE 2.

PLATE 3.

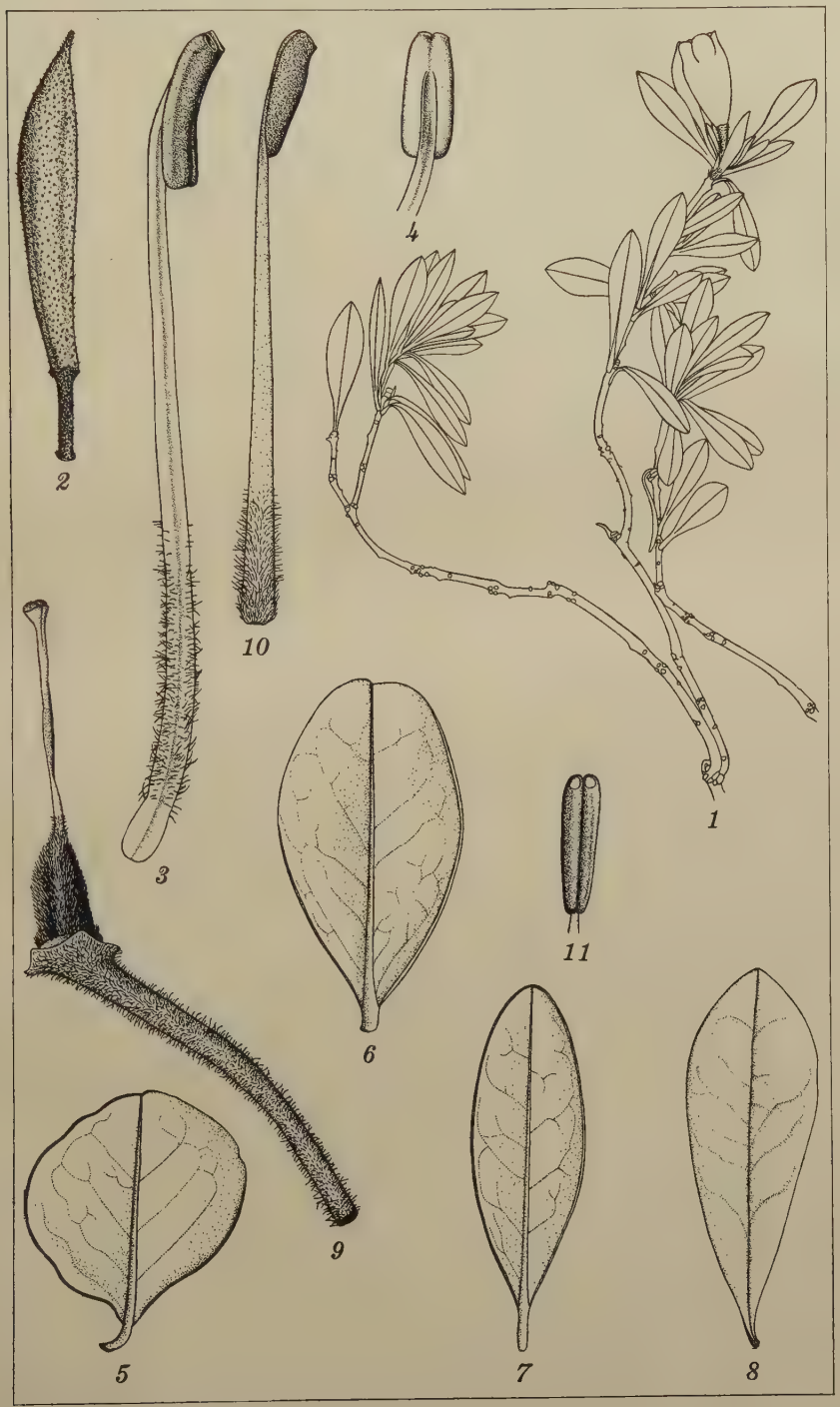
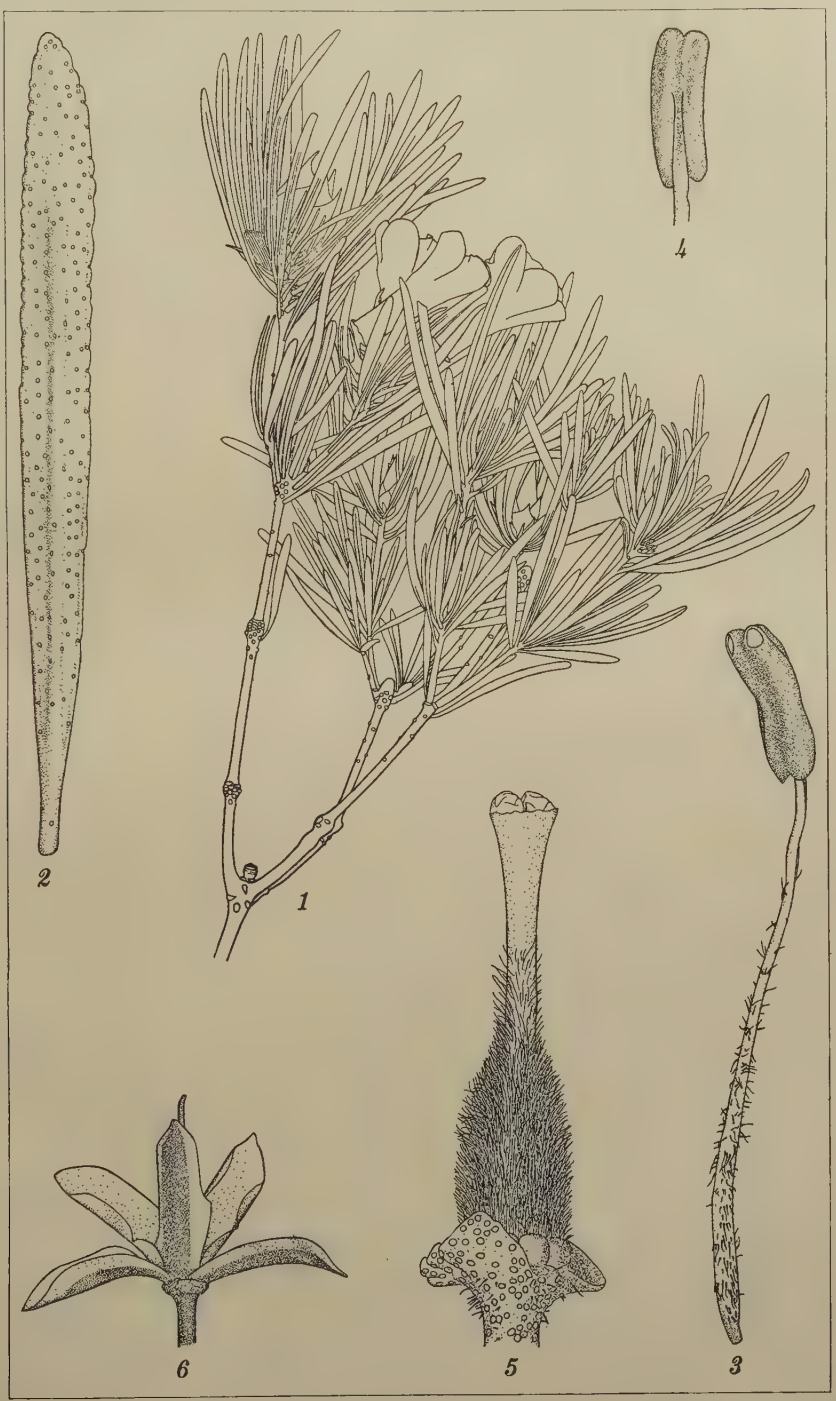


PLATE 4.

PLATE 5.



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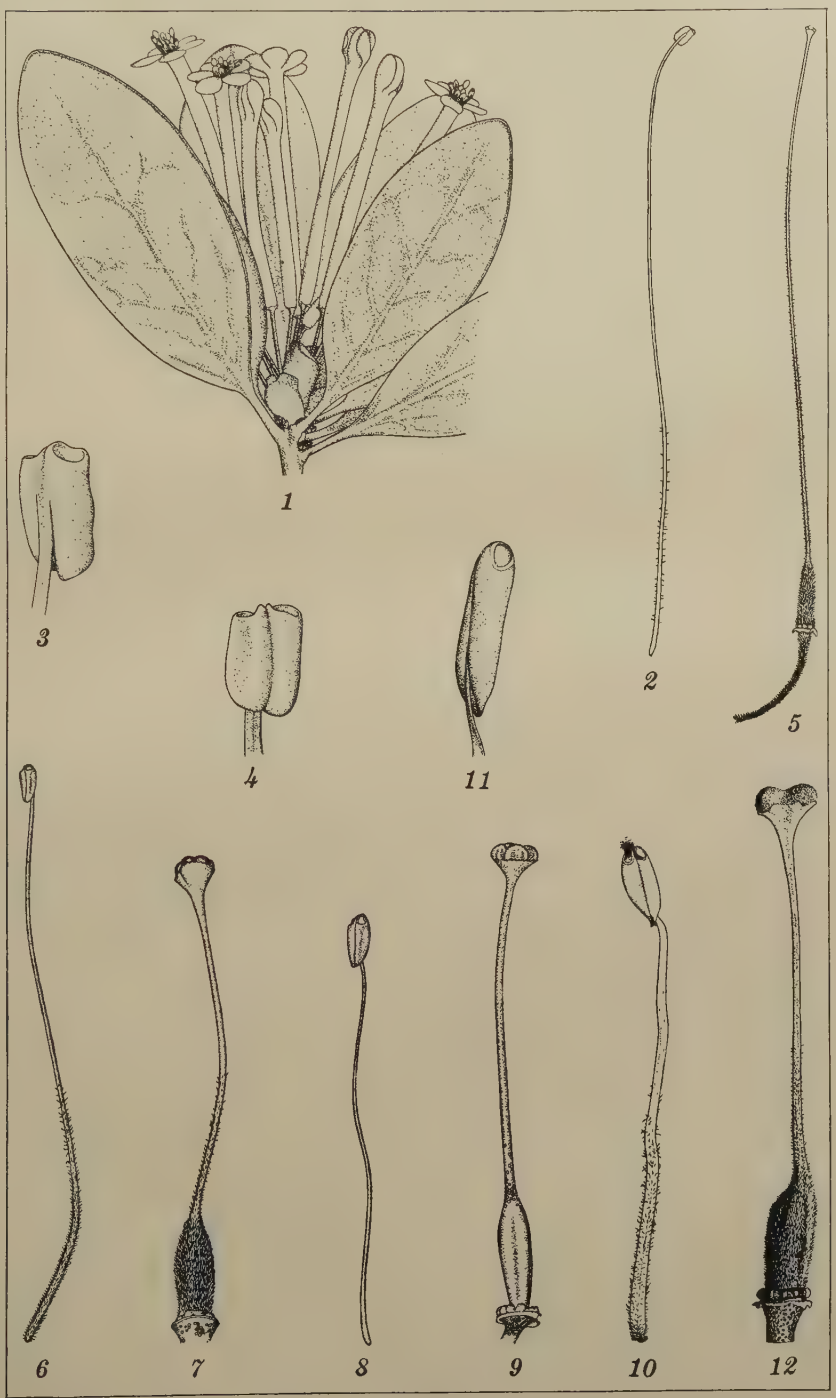


PLATE 7.

PLATE 8.

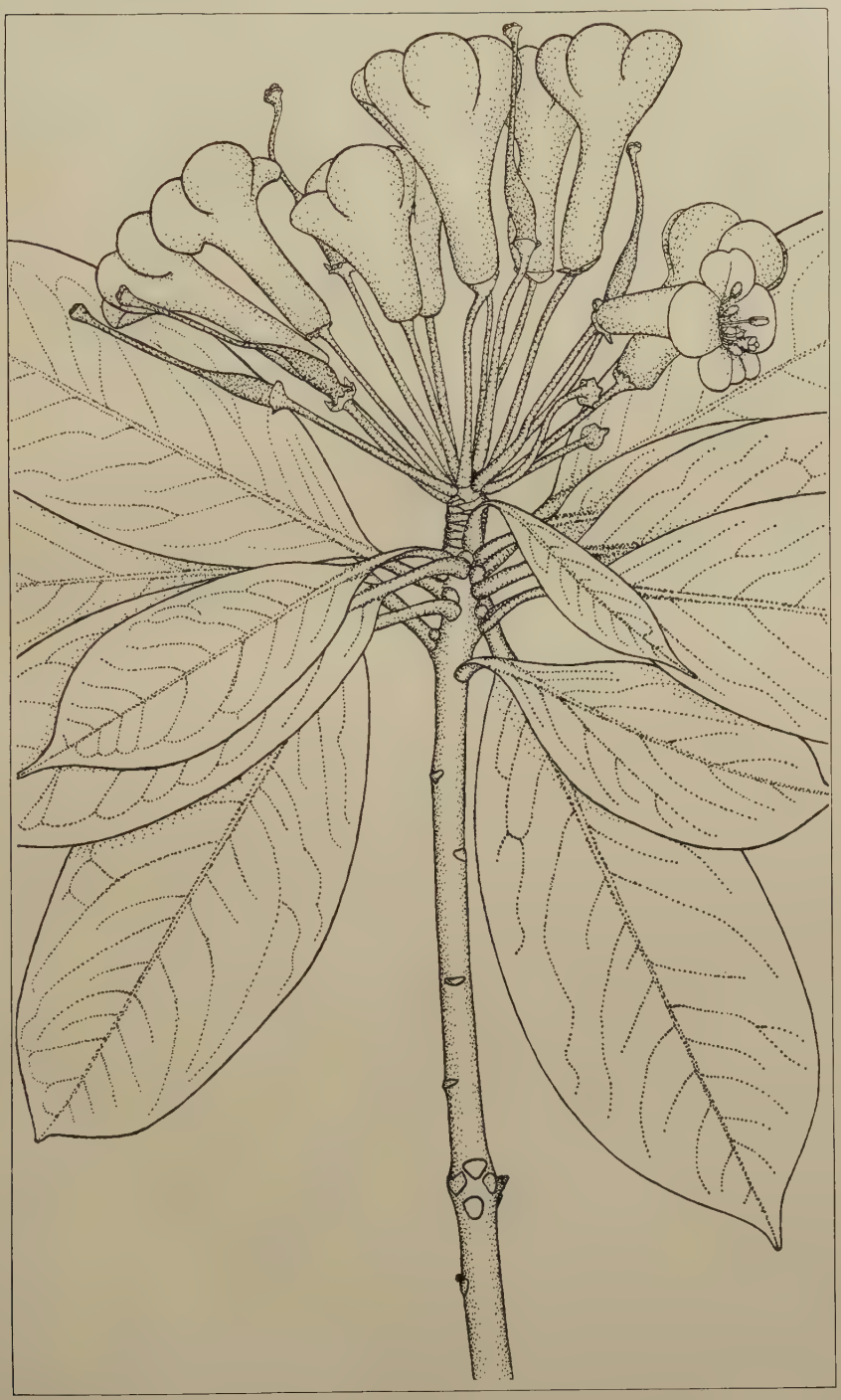
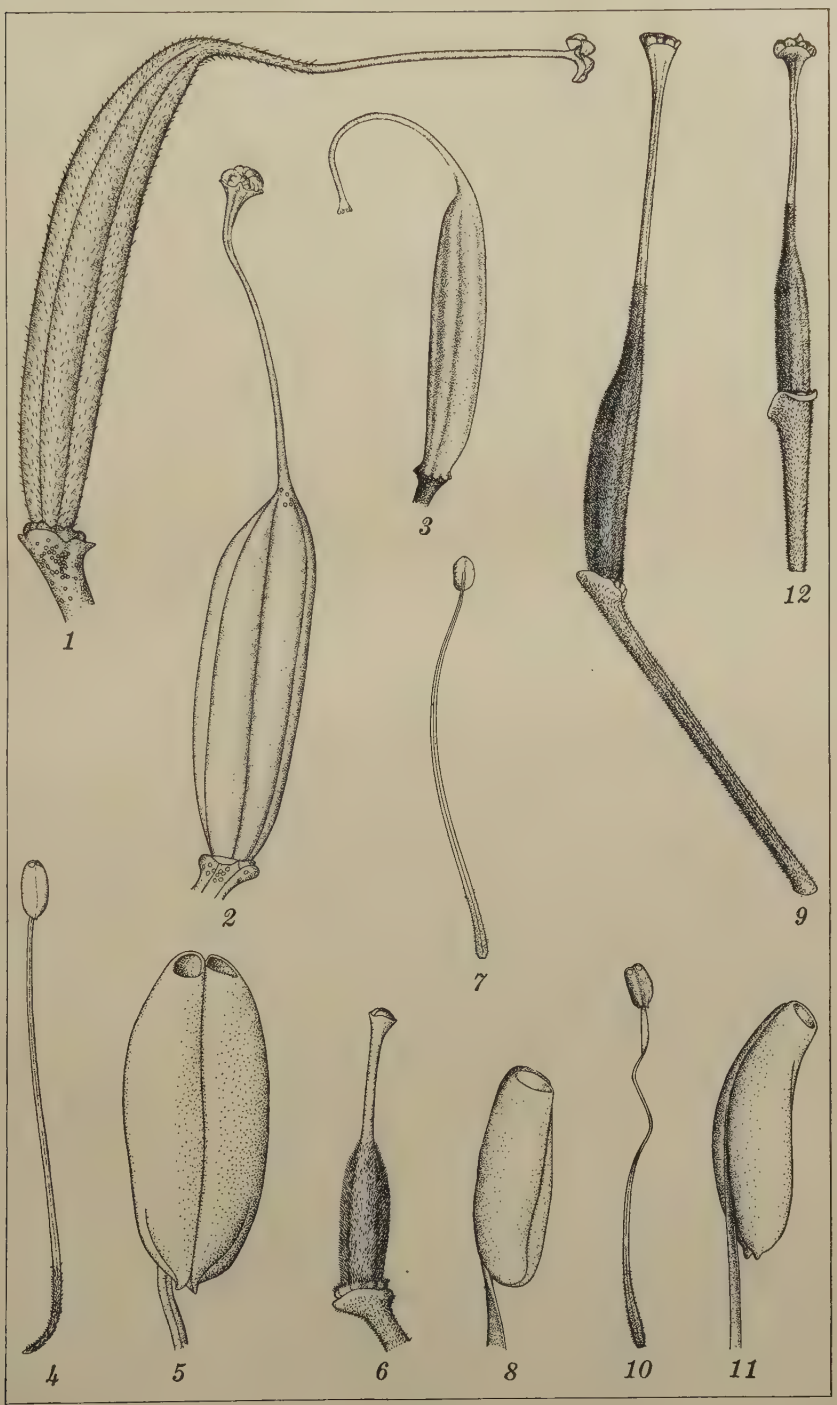


PLATE 9.

PLATE 10.



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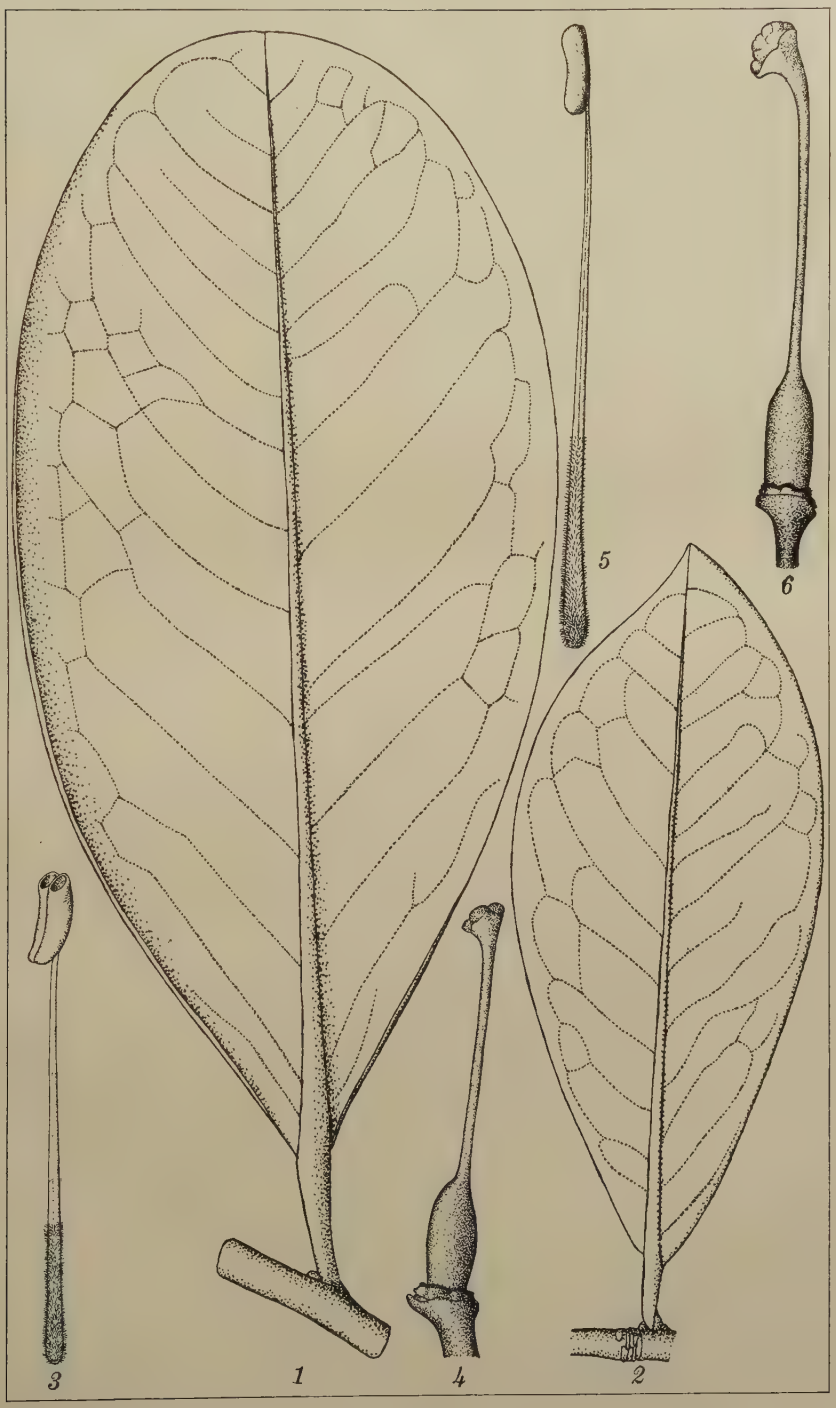

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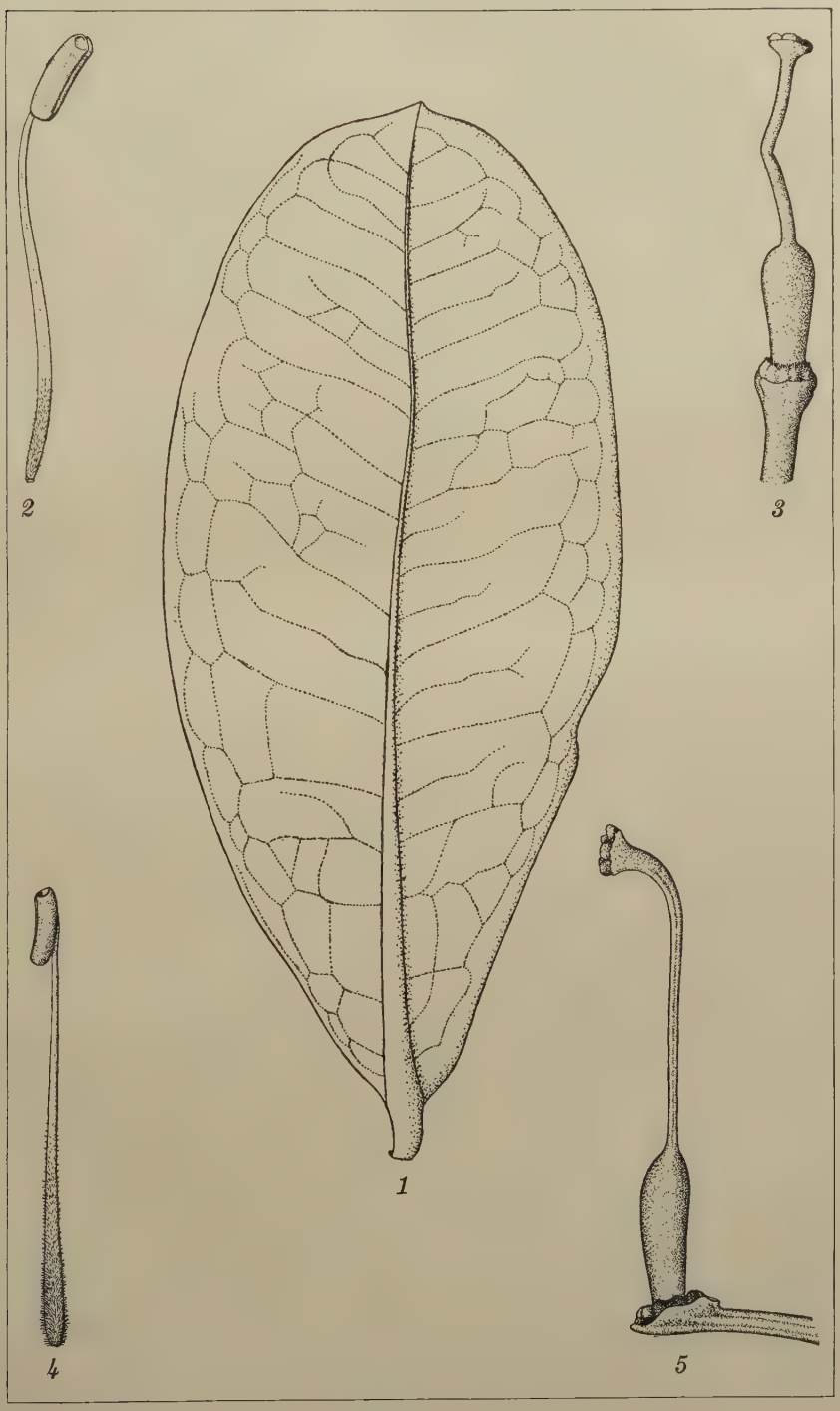

PLATE 13.

PLATE 14.

PLATE 15.

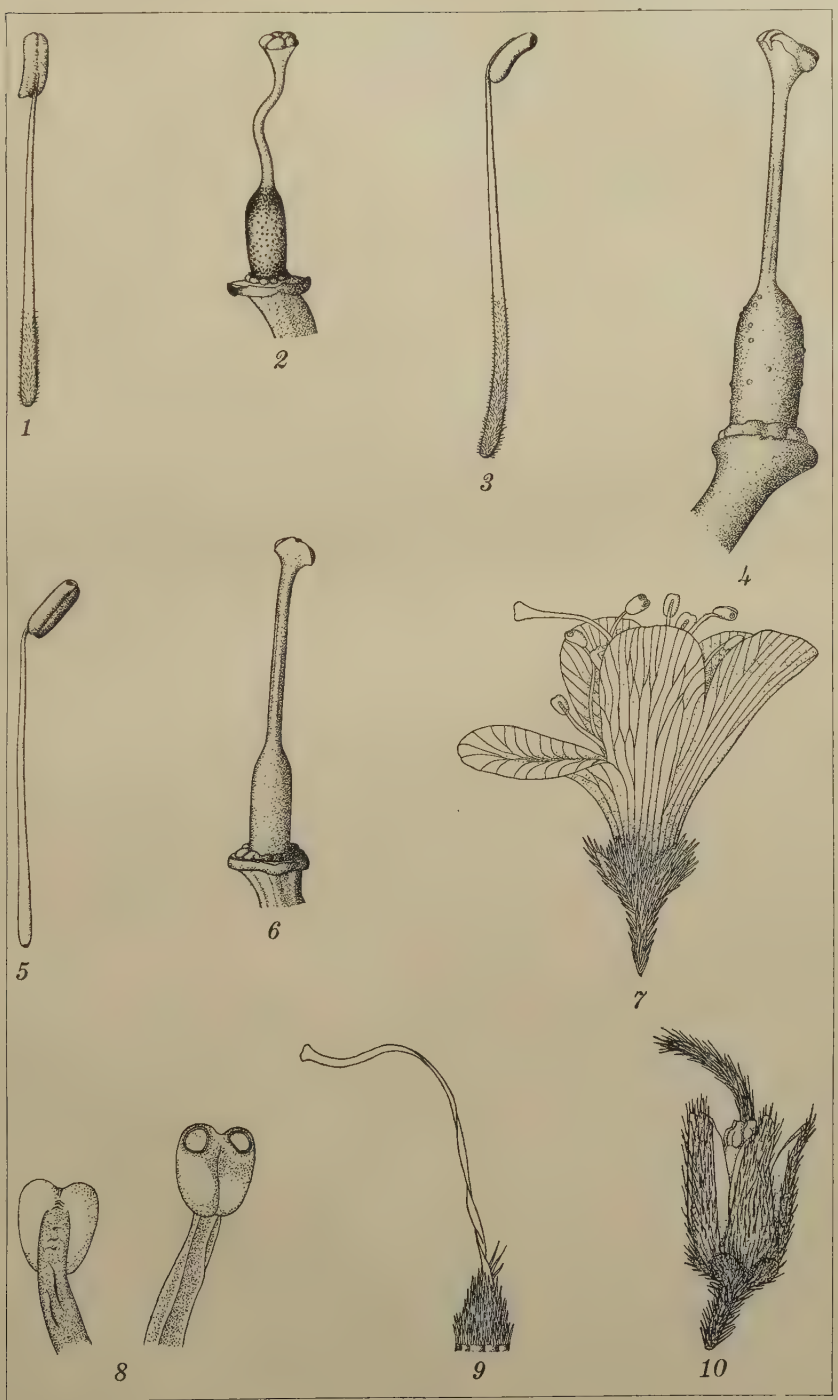

PLATE 16.

A NEW PHILIPPINE SPECIES OF CHLORIS

By E. D. Merrill

Of the University of California, Berkeley, California

The material on which the following description is based has been in my hands for over a year, but only recently has it been possible for me to make a critical examination of it. The genus *Chloris* is very poorly developed in the Malaysian region, with only three or four species in the Philippines, of which one is certainly an introduced weed, originating in tropical America. The species described below is manifestly allied to *Chloris cynodontoides* Balansa originally described from New Caledonia, and more recently recorded from Fiji.[1]

GRAMINEÆ

Genus CHLORIS Swartz

CHLORIS CLEMENTIS sp. nov. Eueleris.

Caulibus tenuibus, compressis, glabris, prostratis, ad nodis radicantibus et ramis fasciculatis erectis gerentibus, ramis gracilibus, 15 ad 30 cm longis, ad basi foliis multis confertis gerentibus; foliis lineari-oblongis, obtusis vel acutis, 1.5 ad 4 cm longis, circiter 2.5 mm latis, margine scaberulis, utrinque glabris vel junioribus supra pilis paucis instructis; vaginis compressis, sursum ad margine ciliatis; spicis 4 ad 7, filiformibus, digitatis, 2 ad 4 cm longis, rhachibus scaberulis, basi haud villosis; spiculis 2 mm longis, sessilibus ad brevissime (0.2 mm) pedicellatis, glumis vacuis submenbranaceis, acutis vel acuminatis, 1-nervis, I 0.3 ad 0.4 mm longis, II duplo longioribus; III (florentibus) oblongo-lanceolatis, 2 mm longis, acutis, aristatis, arista filiformi, recta, scaberula 6 ad 7 mm longa; rhachilla producta (circiter 1 mm longa) glumam vacuam valde reductam vix 0.3 mm longam brevissime aristatam (arista 1 mm longa) ferente.

Luzon, Pangasinan Province, Calasiao, *Mrs. Clemens 17267*, November 30, 1926, and a second collection from the same place, February, 1927, in the thickets near the river, with *Cynodon*.

[1] Kew Bull. (1927) 43.

This species has the general habit of *Chloris tenera* (Presl) Steudel, in that the rather wide creeping stems produce roots and send up tufts of slender erect stems from the nodes, the leaves being crowded near the bases of the erect branches. In floral characters, however, it is totally different, falling in the group with *Chloris incompleta* Roth, while *C. tenera* is a representative of the section (or genus) *Eustachys*. Mr. H. N. Ridley, on the basis of a specimen sent to him direct by Mrs. Clemens, referred this grass to *Chloris cynodontoides* Balansa, of New Caledonia. While it is unquestionably allied to Balansa's species an attentive comparison of the Philippine material with the original description in my opinion indicates altogether too great discrepancies to warrant its reference to the New Caledonian and Fijian species. The bases of the spikes are not villous, and the empty glumes are much shorter, the second being distinctly shorter than the flowering glume, not exceeding it as in Balansa's species.

NOTES ON POTAMOGETONS

By A. Bennett

Of Croydon, England

Through an oversight an error beyond control was discovered in my paper on "The Potamogetons of the Philippine Islands," published in the Philippine Journal of Science 9 (1914) Botany 339–344. On page 344 I referred the following specimens: "Philippine Islands, Luzon, Subprovince of Bontoc, *Vanoverbergh 209, 2684,* eight specimens on three sheets, altitude 1,290 meters, the Igorot name *ibas,*" to *Potamogeton perversus* A. Bennett; these should be *P. tepperi* A. Bennett.

Other Philippine specimens cited under *P. tepperi* A. Bennett were correctly placed.

THE MANUFACTURE OF SUGAR FROM NIPA SAP [1]

By MANUEL L. ROXAS

Of the College of Agriculture, University of the Philippines, Los Baños

EIGHT TEXT FIGURES

INTRODUCTION

The nipa palm, *Nypa fruticans* Wurmb, covers large areas of swamp land in many parts of the Tropics. In the Philippines, and elsewhere, it has served from time immemorial as a source of alcohol and crude sugar.

The palm grows in areas subject to periodical overflow of brackish tide water, usually on low river lands. It is perennial in that it continuously reproduces itself through its branching rhizomes. All the cultivation required is thinning and removal of dead leaves, to prevent overcrowding. In some places, however, the palm is planted, and reaches the bearing age in three to four years.(2) The palm varies in size according to locality. Nipa palms in Luzon are smaller than those in Panay. The palms at Kwala Semawang, British North Borneo, are very tall, and the leaves attain a length of more than 5 meters. The fruit is carried on a stalk borne on the root stock, and sticks out of the ground to a height of about 1 meter.

The sap is collected by cutting the fruit at its point of attachment to the stalk. However, a preliminary treatment is necessary. This consists in kicking or hand-shaking the fruit stalks once a week for from three to six weeks depending on the locality, the condition of the palms, or the whim of the tappers. It

[1] This report was prepared with the coöperation of Hilarion G. Henares and Getulio Guanzon and is based largely on work in the alcohol plant at Semawang, British North Borneo, where they erected a small experimental mill for the Nipa Palm Products Co., for the purpose of studying the best conditions for the manufacture of white sugar from nipa sap.

is claimed that fruit stalks which have not received this treatment do not bleed when tapped.(4)

PREVIOUS WORK ON NIPA-PALM SUGAR

Gibbs(2) was the first to suggest the possibility of manufacturing white sugar directly from nipa sap. Natives of India and the Philippines make a form of crude sugar from the nipa sap by collecting the night flow in clean dry tuquils (bamboo tubes). When such tuquils are used and the sap is collected within twelve hours, only a slight fermentation takes place. When the sap thus obtained is boiled in open pans, there results a brown mass much like the panocha made from cane, but with the flavor characteristic of nipa sugar.

Gibbs(2) demonstrated that with tuquils smeared with thick lime milk, there is practically no fermentation of the sap even after standing for twenty-four hours. The very heavily limed juice may be kept without decomposition for as long as one month.(4) Pratt, Gibbs, and others(3) found this to be true only during the first weeks of tapping while the fruit stalks are still long, but that toward the end of the tapping season lime alone does not preserve the juice. The appearance of a peroxidase in the sap collected from short stalks oxidizes the sucrose even in strongly alkaline solution. It was found that a small amount of sodium bisulphite in the milk of lime used in smearing the tuquils completely stops the action of the peroxidase. These findings are of fundamental importance in the collection of sap for white-sugar manufacture.

Several modifications of the smeared-tuquil method have been proposed. The purpose of these modifications is to reduce the amount of lime and to make its distribution in the sap more uniform.

Pratt, Gibbs, and co-workers(3) proposed the use of a funnel to carry the juice to the bottom of the tuquil containing the milk of lime, thus avoiding the tendency of the sap to form layers of gradually decreasing alkalinity. They state that even in tuquils heavily smeared with lime the top layer is often found very weakly alkaline or acidic due to fermentation because of the settling to the bottom of the heavily limed juice.

Wells and Perkins(4) proposed the use of a funnel with a bamboo head piece, a small boho stem, and a wire attachment to hold the tuquil and funnel in position.

THE COLLECTION OF SAP AT SEMAWANG

During our work at Semawang several apparently new ideas were developed. Mr. D. D. Wood, conservator of forests, State of North Borneo, conducted experiments with closed tuquils. His idea was to reduce the circulation of air necessary to the action of the peroxidase and the number of microörganisms responsible for the decomposition of the sugar in sap, and to keep out insects, which are attracted by the sweet sap and constitute the principal source of infection, besides causing some trouble in the factory, since a great number of them become drowned in the sap and must be strained out.

The idea of using moist, solid, water-slaked lime carried on a wooden float was conceived. The main difficulty in the use of the float is the tendency of the lime to drop after contact with the sap for several hours.

Another idea proposed was to use a wick soaked in lime, or lime-bisulphite mixture when the latter is needed. The wick should be hung from the mouth of the tuquil and extend to the bottom. The great objection to this method is that relatively large amounts of sap adhere to the cloth, which has to be thoroughly washed to recover sugar that would otherwise be lost.

A fourth idea, the cup method, consists in the use of a small can carried on the hole in the tuquil as shown in fig. 1. The can is provided with a baffle plate and carries either milk of lime or paste of water-slaked lime at the bottom. The purpose of the baffle plate is to force the sap to pass to within a few millimeters of the surface of the milk of lime and thus carry enough of it to make it strongly alkaline before it drops to the bottom of the tuquil.

All these methods were tried, and the results are given in the accompanying tables. Through lack of time and facilities at Semawang for making some of the devices suggested, we discontinued such experiments and resorted to the use of the original Gibbs method of collecting juices for the manufacture of sugar on a commercial scale. Mr. Wood, however, ordered for trial one hundred galvanized-iron tubes provided with cap and rubber attachment, as shown in fig. 2. The tubes did not arrive until near the close of the season, and only a few trials could be run with them. The result of these trials are given in Tables 1, 2, 3, 4, 5, and 6.

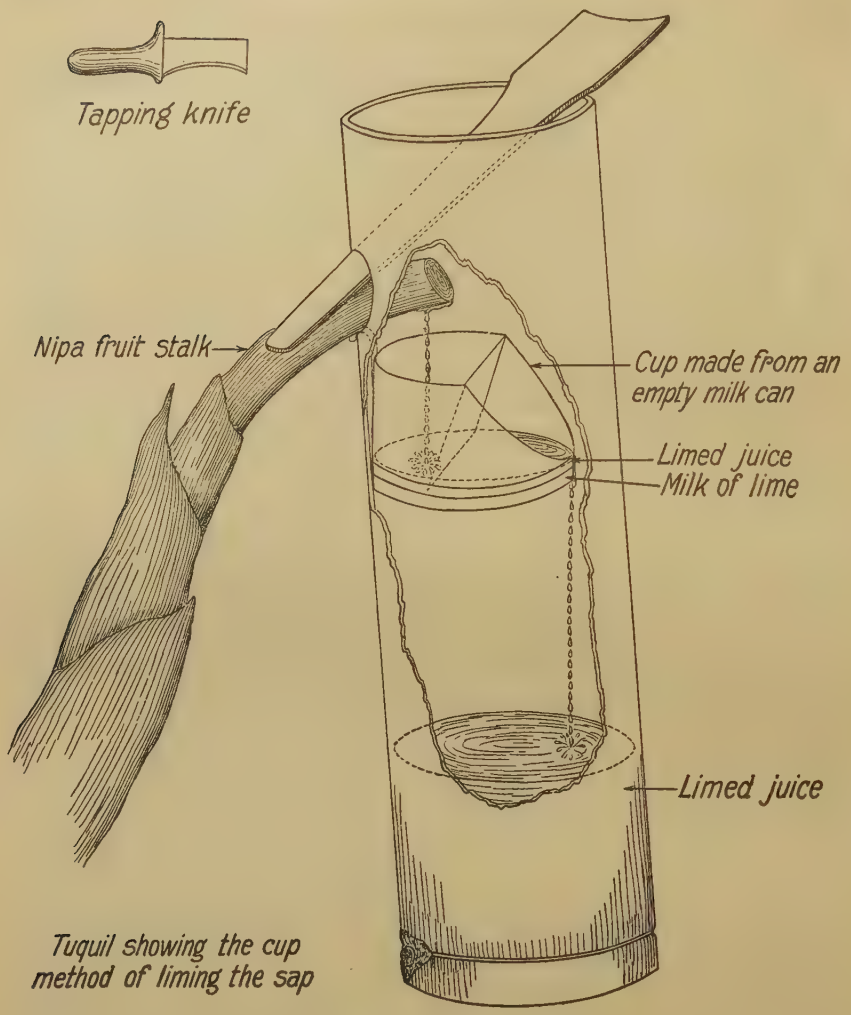

FIG. 1. The cup method of liming nipa.

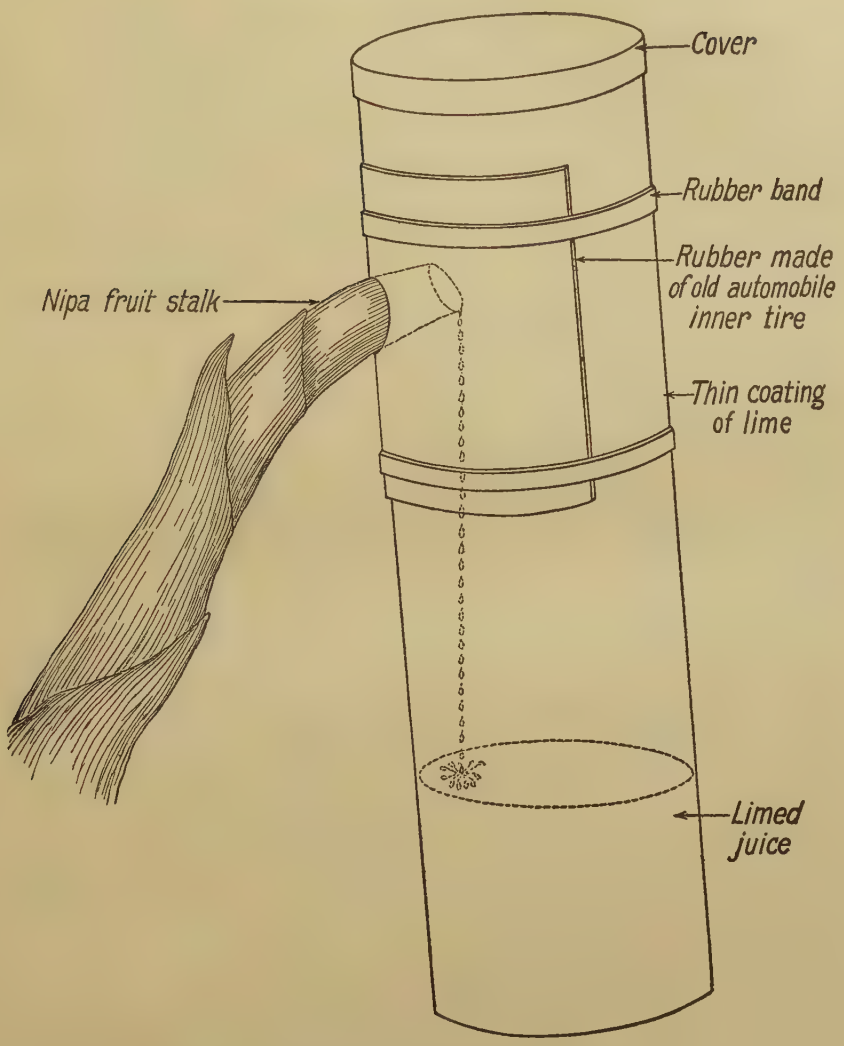

FIG. 2. The Wood tin tube for collecting nipa sap.

TABLE 1.—*Preservation of nipa sap.*

RUN 1; NIGHT FLOW; APRIL 21 TO 22, 1925.

Stand No.	Treatment.	Test-tube samples.				Tuquil samples.			
		1 per cent polarization.	2 per cent polarization.	Average per cent polarization.	Average of each treatment.	C. Brix.	Per cent polarization.	Average polarization of each treatment.	Alkalinity.
1	Float method	16.3	14.9	15.6		18.16	14.9		
2	Do	16.2	14.8	15.5		17.62	(a)		
3	Do	19.9	18.0	19.0	16.7	20.86		14.9	
4	Smearing method	15.6	14.6	15.1		17.76	15.1		+1.9
5	Do	18.3	17.4	17.8		20.06	17.1		+2.5
6	Do	17.4	15.8	16.6	16.5	18.86	16.5	16.4	+1.4
7	Funnel method	17.7	17.2	17.5			15.2		
8	Do	16.8	15.4	16.1		18.16	16.4		
9	Do	18.2	16.5	17.5	17.0	19.59	16.9	15.8	+3.8
	Average	17.4	16.1	16.8		18.88	16.0		

RUN 2; NIGHT FLOW; APRIL 22 TO 23, 1925.

1	Float method	16.5	14.2	15.3		(b)			
2	Do	16.8	14.2	15.5					
3	Do	19.0	17.7	18.4	16.4				
4	Smearing method	16.8	14.5	15.5					
5	Do	18.7	16.8	17.8					
6	Do	17.2	16.6	16.9	16.7				
7	Funnel method	17.2	17.1	17.1					
8	Do	16.9	15.3	16.1					
9	Do	18.0	16.5	17.2	16.8				
	Average	17.5	15.8	16.7					

RUN 3; DAY FLOW; APRIL 23, 1925.

Stand No.	Treatment.	Test-tube samples.				Tuquil samples.			
		1 Per cent polarization.	2 Per cent polarization.	3 Per cent polarization.	Average of each treatment.	C. Brix.	Per cent polarization.	Average polarization of each treatment.	Alkalinity.
1	Float method	14.2	14.8	14.5			12.6		
2	Do	14.2	15.3	14.7		Brix			
3	Do	17.7	18.2	17.9	15.7		17.3	15.0	
4	Smearing method	14.3	14.7	14.5		not	12.7		
5	Do	16.8	16.6	16.7			15.3		
6	Do	16.5	16.5	16.5	15.9	taken	14.4	14.1	
7	Funnel method	17.1	17.2	17.2					
8	Do	15.5	16.6	15.9			14.7		
9	Do	16.5	17.6	17.0	16.7		15.9	15.8	
	Average	16.9	16.4	16.2			14.7		

RUN 4; NIGHT FLOW; APRIL 23 TO 24, 1925.

1	Float method	14.8	13.9	14.3					
2	Do	15.3	13.9	14.6		18.11	13.4		2.0
3	Do	18.2	14.9	17.6	15.5	20.17	10.9	12.2	
4	Smearing method	14.7	13.8	14.2		18.24	13.5		25.0
5	Do	16.6	17.6	17.1		25.37	16.7		51.5
6	Do	16.5	16.6	16.6	16.0	20.57	14.8	15.0	27.3
7	Funnel method	17.2	16.5	16.8		21.11	14.0		27.0
8	Do	16.6	14.9	15.8		17.77	16.6		2.5
9	Do	17.6	16.5	17.0	16.5	20.71	14.2	14.9	29.5
	Average	16.4	15.6	16.0		20.09	14.5		

[a] Too dark to polarize.

[b] The juice fermented before it could be analyzed.

TABLE 1.—*Preservation of nipa sap*—Continued.

RUN 5; DAY FLOW; APRIL 24, 1925.

Stand No.	Treatment.	Test-tube samples.				Tuquil samples.			
		1 Per cent polarization.	2 Per cent polarization.	Average per cent polarization.	Average of each treatment.	C. Brix.	Per cent polarization.	Average polarization of each treatment.	Alkalinity.
1	Float method	13.9	15.3	14.6			13.8		13.6
2	Do	13.9	16.2	15.0		19.24	14.3		14.0
3	Do	16.9	18.2	17.6	15.7	21.31	16.6	14.9	10.5
4	Smearing method	13.8	14.3	14.0			13.2		12.5
5	Do	17.6	18.4	18.0			16.9		20.2
6	Do	16.6	16.3	16.4	16.1	20.11	14.8	15.0	27.8
7	Funnel method	16.5	17.1	16.8			14.2		13.9
8	Do	14.9	15.5	15.2			13.9		38.4
9	Do	16.5			16.0		14.2	14.1	
	Average	15.6	16.4	16.0		20.2	14.7		

RUN 6; NIGHT FLOW; APRIL 24 TO 25, 1925.

1	Float method	15.3	[c]	15.3		17.6	13.5		5.7
2	Do	16.2		16.2		17.3	10.0		[d]
3	Do	13.2		18.2	16.6	14.5	10.7	11.4	[d]
4	Smearing method	14.3		14.3		17.4	12.6		11.2
5	Do	18.4		18.4		21.2	17.1		16.0
6	Do	16.3		16.3	16.3	19.6	14.9	14.9	16.0
7	Funnel method	17.1		17.1		18.5	12.1		3.2
8	Do	15.5		15.5		17.6			[d]
9	Do				16.3	18.4	13.1	12.6	6.5
	Average	16.4		16.4		18.00	13.00		

[c] Fermented before it could be analyzed.

[d] Neutral.

TABLE 2.—*The preservation of nipa sap.*

RUN 1; NIGHT FLOW; APRIL 29 TO 30, 1925.

Stand No.	Treatment.	Test-tube samples.				Tuquil samples.				
		1 Per cent polarization.	2 Per cent polarization.	Average per cent polarization.	Average polarization of each treatment.	C. Brix.	Per cent polarization.	Average polarization of each treatment.	Alkalinity.	Average of each treatment.
1	Float method	16.9	15.2	16.0		18.2	16.0		1.4	
2	Do	15.9	14.7	15.3		18.3	14.8		4.0	
3	Do	15.0	12.7	13.8	15.0	16.0	13.6	14.8	0.6	2.0
4	Smearing method	18.5	17.1	17.8		20.6	16.8		6.7	
5	Do	15.1	15.9	14.5		17.0	13.7		3.5	
6	Do	15.4	14.0	14.7	15.7	16.0	14.5	15.0	1.7	4.0
7	Funnel method	16.5	15.5	16.0					1.6	
8	Do	13.3	11.9	12.6		14.4	12.1		0.9	
9	Do	15.6	13.9	14.7	14.4	16.7	14.7	13.4	0.7	1.1
	Average	15.8	14.3	15.0		17.2	14.5		2.3	

RUN 2; DAY FLOW; APRIL 30, 1925.

1	Float method	16.2	16.0	15.6		18.58	13.94		11.7	
2	Do	14.7	15.5	15.1		19.16	13.23		17.3	
3	Do	12.7	14.5	13.6	14.8	16.96	10.85	12.67	15.9	15.0
4	Smearing method	17.1	17.1	17.1						
5	Do	13.9	14.3	14.1						
6	Do	14.0	14.6	14.3	15.2	18.36	13.36	13.36	13.5	13.5
7	Funnel method	15.5	16.1	15.8		17.36	15.11		0.3	
8	Do	11.9	12.8	12.3					2.8	
9	Do	13.9	14.4	14.1	14.1			15.11	6.0	3.0
	Average	14.3	15.0	14.6		18.08	13.3		9.6	

TABLE 2.—*The preservation of nipa sap*—Continued.

RUN 3; NIGHT FLOW, APRIL 30, TO MAY 1, 1925.

Stand No.	Treatment.	Test-tube samples.				Tuquil sample.				
		1 Per cent polarization.	2 Per cent polarization.	Average per cent polarization.	Average polarization of each treatment.	C. Brix.	Per cent polarization.	Average polarization of each treatment.	Alkalinity.	Average of each treatment.
1	Float method	16.0	14.4	15.2		17.52	10.78		[a]	
2	Do	15.5	14.0	14.7		17.72	11.46		[b]	
3	Do	14.5	12.3	13.9	14.6	15.62	9.68	10.64	[b]	
4	Smearing method	17.1	16.5	16.8		18.52	12.19		2.4	
5	Do	14.3	12.1	13.7		14.92	9.26		0.6	
6	Do	14.6	13.6	14.1	14.7	17.42	11.46	10.97	[b]	
7	Funnel method	16.1	14.8	15.4		16.92	13.36		4.2	
8	Do	12.8	11.3	12.0		14.42	10.17		5.4	
9	Do	14.4	13.9	14.1	13.8	14.92	11.18	11.57	[a]	
	Average	15.0	13.7	14.3		16.44	11.06			

RUN 4; DAY FLOW; MAY 1, 1925.

1	Float method	14.4	15.6	15.0		17.16	10.95		3.0	
2	Do	14.0	15.4	14.7		16.62	11.26		1.4	
3	Do	12.3	14.5	13.4	14.4	16.22	10.84	11.02	11.1	4.8
4	Smearing method	16.5	17.2	16.8					18.7	
5	Do	12.1	14.0	13.0					18.8	
6	Do	13.6	14.7	14.1	14.6	17.06	11.72	11.72	13.7	17.1
7	Funnel method	14.8	16.8	15.8		17.84	14.35		4.4	
8	Do	11.3	12.3	11.8		14.94	9.87		9.6	
9	Do	13.9	11.5	12.7	13.4	15.26	11.40	11.87	2.0	5.3
	Average	13.7	14.7	14.4		16.44	11.48		9.1	

[a] Slightly acidic.

[b] Acidic.

TABLE 3.—*Experiments with closed tuquils conducted by Mr. D. D. Wood.*

STAND A.

Date.	Brix.	Polarization.	Purity.	Alkalinity.	Time.
					Hrs.
May 6	17.19	12.90	75.0	Slightly acidic	14
May 7	16.99	10.01	59.0	....do	24
May 8					
May 9	16.01	8.54	53.4	Acidic	24
May 10	18.20	8.56	47.1	Slightly acidic	24
May 12	20.02	14.72	73.6	10.6	24
May 13	17.81	9.49	53.5	Acidic	24
Average	17.70	10.70	60.5		

STAND B.

May 6	18.66	12.14	65.2	Slightly acidic	14
May 7	16.89	12.89	74.3	....do	24
May 8					
May 9	18.30	12.48	68.3	3.5	24
May 10	17.7	11.02	62.3	Neutral	24
May 12	19.32	15.28	79.8	6.4	24
May 13	18.71	10.92	58.4	Acidic	24
Average	18.26	12.46	68.2		

STAND C.

May 6	18.99	14.01	73.7	2.7	14
May 7	13.19	8.24	62.6	Slightly acidic	24
May 8	13.2	3.68	27.9	Acidic	24
May 9	12.99	2.23	17.2	Neutral	24
May 10	14.0	7.12	50.8	Slightly alkaline	24
May 12	14.82	11.72	79.1	2.1	24
May 13	14.21	5.69	40.1	Acidic	24
Average	14.49	7.53	52.0		

STAND D.

May 6					
May 7	13.79	10.28	79.0	Slightly acidic	24
May 8	13.70	5.35	39.1	Acidic	24
May 9	13.49	2.48	18.4	....do	24
May 10	13.70	4.16	30.4	Slightly acidic	24
May 12	15.62	12.58	30.6	1.8	24
May 13	15.21	4.40	42.2	Acidic	24
Average	14.25	7.00	49.1		

STAND E.

May 6					
May 7	15.09	12.46	82.5	Neutral	24
May 8	15.00	9.80	65.4	Acidic	24
May 9	14.70	4.39	29.9	....do	24
May 10	14.90	7.39	49.7	Neutral	24
May 12					
May 13					
Average	14.92	8.51	57.0		

TABLE 4.—*Results with the cup method of distributing lime.*

Stand No.	May 10, 1925.				May 11, 1925.				May 12, 1925.			
	C. Brix.	Polarization.	Purity.	Alkalinity.	C. Brix.	Polarization.	Purity.	Alkalinity.	C. Brix.	Polarization.	Purity.	Alkalinity.
1	20.81	13.35	66.6	3.7	19.89	11.10	55.8	[b]	[a]	[a]	[a]	
2	[a]	[a]	[a]	[b]	20.99	16.49	78.6	4.0	18.96	13.26	80.5	1.9
3	20.61	16.96	82.2	4.3	21.69	17.51	80.7	3.3	19.46	15.28	78.6	[c]
4	20.78	14.71	70.8	8.9	19.19	15.36	80.0	[c]	21.16	16.69	78.8	5.0
5	20.51	16.23	79.3	3.6	18.89	11.87	62.8	[c]	[a]	[a]	[a]	
6	20.28	12.19	60.01	2.6								
7	19.88	16.51	83.2	2.4								
8	22.11	16.99	76.8	8.6								
Average[d]	20.71	15.35	74.12	4.9	20.13	14.47	71.9	1.5	19.86	15.74	79.3	2.3

[a] Fermented. [b] Acidic. [c] Neutral. [d] General average: C. Brix, 20.23; per cent polarization, 15.19; purity, 75.1; alkalinity, 2.9 cubic centimeters.

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TABLE 5.—*Comparative results obtained by using tin and bamboo tuquils.*

Date.	Coolie 2.								Coolie 5.							
	Tin.				Bamboo.				Tin.				Bamboo.			
	C. Brix.	Polarization.	Purity.	Alcalinity.	C. Brix.	Polarization.	Purity.	Alcalinity.	C. Brix.	Polarization.	Purity.	Alcalinity.	C. Brix.	Polarization.	Purity.	Alcalinity.
May 24	19.58	12.72	65.0	2.7	21.08	13.70	65.3	4.3	18.18	11.34	62.4	3.9	18.96	12.36	65.2	4.8
May 25	20.90	12.50	59.8	12.3					17.70	10.83	61.0	7.4				
May 26	20.6			13.4	19.50			6.6	18.00			11.5				
May 27	20.4			13.6					18.6			12.5				
May 28	21.8	11.97	54.9	20.2					20.0	10.28	51.4	20.9				
May 29	20.7	12.19	58.9	13.4					18.6	11.07	59.5	5.9				
May 30	20.51	13.49	65.8	13.4					17.31	11.21	64.8	7.2				
General average																

Date.	Coolie 8.								Average.							
	Tin.				Bamboo.				Tin.				Bamboo.			
	C. Brix.	Polarization.	Purity.	Alcalinity.	C. Brix.	Polarization.	Purity.	Alcalinity.	C. Brix.	Polarization.	Purity.	Alcalinity.	C. Brix.	Polarization.	Purity.	Alcalinity.
May 24	19.78	13.51	68.3	3.8	19.68	11.12	56.5	6.1	19.18	12.52	65.3	3.5	19.91	12.39	62.2	5.1
May 25	19.8	15.0	75.7	8.7	19.80	12.8	64.6	13.8	19.47	12.78	65.6	9.5	19.80	12.8	64.6	13.8
May 26	20.31	12.09	59.5	12.7	19.21	10.95	57.3	9.2	19.64	12.09	61.6	12.5	19.36	10.95	56.6	7.9
May 27	20.61	11.08	57.3	15.4	20.54	11.80	57.6	15.4	19.87	11.80	59.4	13.8	20.54	11.80	57.6	15.4
May 28	21.5	12.09	59.2	16.4	20.60	11.71	56.8	11.9	21.10	11.45	54.3	19.2	20.60	11.71	56.8	11.9
May 29	19.1	10.90	57.1	3.8					19.47	11.39	58.5	7.7				
May 30	21.01	12.26	58.4	17.2	21.11	11.29	53.5	13.2	19.61	18.32	62.8	12.6	21.11	11.29	53.5	13.2
General average									19.76	12.05	61.0	11.3	20.22	11.82	58.5	11.2

TABLE 6.—*Composition of test-tube samples from various fields, May 30, 1925.*

Stand No.	Field 1.			Field 2.			Field 3.			Field 4.			Field 5.			Field 8.		
	Refractometer solids.	Polarization.	Purity.	Refractometer solids.	Polarization.	Purity.	Refractometer solids.	Polarization.	Purity.	Refractometer solids.	Polarization.	Purity.	Refractometer solids.	Polarization.	Purity.	Refractometer solids.	Polarization.	Purity.
1	21.0	17.83	84.9	19.3	16.20	83.9	18.2	14.70	80.8	20.3	17.24	84.9	19.9	17.37	87.3	19.6	16.49	84.6
2	19.4	13.33	79.0	21.0	18.40	87.6	20.5	16.91	82.5	19.9	17.09	85.9	18.0	15.38	85.4	22.1	17.34	78.5
3	19.3	14.42	73.9	18.4	15.05	81.8	21.3	16.69	78.4	22.0	19.82	90.1	19.0	16.96	89.3	22.6	18.77	83.1
4	19.3	15.38	79.7	19.3	16.35	84.7	20.4	18.64	91.4	20.3	17.20	84.7	18.9	16.09	85.1	21.4	17.51	81.8
5	21.3	17.53	82.4	22.0	19.62	89.2	20.6	17.48	84.9	20.0	17.18	85.9	19.0	16.72	88.0	19.9	17.28	86.8
6	19.4	14.51	74.8	19.9	17.04	85.6	20.6	17.87	86.7	20.2	17.28	85.5	20.1	17.81	88.6	21.0	17.25	82.1
7	20.7	17.58	84.9	19.3	16.83	86.3	22.0	18.96	86.2	21.5	17.80	82.8	19.0	15.99	84.2	20.2	16.89	83.6
8	21.3	18.09	84.9	21.1	16.22	80.2	20.6	17.06	82.8	20.0	17.42	87.1	18.5	15.98	86.4	21.5	18.13	84.3
9	18.7	15.25	81.6	21.0	18.31	87.2	20.4	17.30	84.8	19.3	15.33	79.4	19.9	17.04	85.6	23.0	19.36	84.2
10	19.5	16.06	82.4	21.2	16.60	87.7	19.9	16.61	87.5	19.7	17.08	86.7	19.3	16.88	87.5	19.3	16.54	85.7
Average [a]	20.61	16.20	80.85	20.3	17.33	85.4	20.45	17.22	84.2	20.32	17.34	85.3	19.16	16.62	86.7	21.05	17.55	83.4

[a] General average: Refractometer, 20.3; per cent polarization, 17.04; purity, 83.94.

RESULTS OF COLLECTION EXPERIMENTS

Several reasons led us to adopt the original Gibbs smeared-tuquil method for the commercial collection of sap. Of all the methods tried, it is the simplest and surest. We discovered too that strong alkalinity in the juice is unobjectionable, and is even desirable in sugar manufacture, since heavy liming is very effective in removing gums and resinous matter found in the nipa sap collected by the ordinary process.

During the first few weeks of collection, we followed the recommendation of Pratt and others(3) to pass sulphur dioxide through lime instead of using sodium bisulphite as they did in their experiments, believing with them that such treatment was sufficient to stop the activity of the peroxidase, which we supposed was present in the sap, since at the time we conducted our experiments, the fruit stalks had already been tapped for several months and were nearing the end of the season. As may be seen in Tables 8 and 9, giving the composition of juices from day to day, we were having trouble in collecting good juices at first and by no method we used could we obtain juice good enough for white-sugar manufacture. The sucrose content was much less than that found in saps collected directly in clean test tubes containing a few drops of toluene. All the stands being tapped in one field were examined for peroxidase, and we found positive proof of its presence in every case, as is shown by the effect on tincture of guaiacum; in many cases the addition of hydrogen peroxide was unnecessary to bring out the blue color.

In view of the fact that we were obtaining poor juices with the use of lime milk treated with sulphur dioxide, we decided to use lime milk mixed with sodium bisulphite prepared from sodium carbonate and sulphur dioxide and later from sodium hydroxide and sulphur dioxide. The lime milk was mixed as follows:

A solution of 4 per cent sodium carbonate was made. Sulphur dioxide was passed through it until acidic, and the solution thus made was used in preparing a thick lime milk of 50° Brix, which was used in smearing the tuquils in a central station. The smearing was done by putting a small amount of lime milk in the tuquil and pouring it out, rotating the tuquil at the same time, so that its sides were thoroughly soaked in lime. The

tuquil was then allowed to drain as completely as possible. The following instructions were issued for the guidance of the coolies:

May 6, 1925.

COLLECTION OF SAP USING SEVEN MALAYS AND THE SMEARING METHOD

1. Each Malay to have two tuquils per stump.
2. The tuquils to be smeared with lime-bisulphite mixture every twenty-four hours as follows:
   (*a*) All tuquils to be brought in to the smearing station where they will be cleaned, smeared, and drained, and made ready for use.
   (*b*) On first day at 2 p. m. tuquil set No. 1, smeared and ready for use, will be taken to the grove and hung on the stumps replacing tuquils Nos. 2, which will then be gathered and brought to the smearing station. The small amount of day flow to be collected and brought in to the factory at the same time.
   (*c*) On the following morning the night flow is collected. Tuquils Nos. 1 are rinsed with a little water and used again for the day-flow, floats with lime being used this time.
   (*d*) In the afternoon tuquil set No. 2, which must be ready for use will be taken to the grove to replace tuquils Nos. 1, as in (*b*), and thus the cycle of operations is repeated.
3. Mornings and afternoons the stumps must be washed with a little water, and then tapped.
4. Each coolie will take to the field the following:
   A. In the morning—
      1. Floats.
      2. Two half canfuls of water, one to be used for rinsing the stumps in the afternoon.
      3. One or more empty cans for the sap according to the amount that may be collected.
      4. Tapping knife.
   B. In the afternoon—
      1. The smeared tuquils.
      2. The empty cans.
      3. The tapping knife.
5. For the next three days one responsible person will accompany each coolie to see that he has understood instructions and to teach him how to recognize badly fermented sap with the help of litmus paper and from the appearance.
6. In collecting from each tuquil, sap that shows frothing must be placed in a different can from sap showing no frothing. Saps that are acid must be thrown away.

After adopting the method of smearing the tuquils in a central station and using sodium bisulphite, we had no further trouble in collecting good juices.

TABLE 7.—*Showing relative strength of alkali needed in preservation.*

Date.	Grams of calcium oxide (CaO) per 400 cubic centimeters of juice.											
	0.4 g. C. Brix = 20.08.		0.8 g. C. Brix = 20.18.		1.2 g. C. Brix = 20.48.		1.6 g. C. Brix = 20.78.		2.0 g. C. Brix = 20.74.		2.4 g. C. Brix = 21.17.	
	Polarization read.	Alkalinity.	Polarization read.	Alkalinity.	Polarization read.	Alkalinity.	Polarization read.	Alkalinity.	Polarization read.	Alkalinity.	Polarization read.	Alkalinity.
1925		*cc. n/5.*		*cc. n/5.*		*cc. n/5.*		*cc. n/5.*		*cc. n/5.*		*cc. n/5.*
April 28	36.7	1.0	37.0	1.7	37.7	3.1	36.5	4.2	36.5	5.9	36.5	7.3
April 29	36.7	0.95	36.9	1.7	36.5	3.05	36.5	4.25	36.5	5.8	36.6	7.4
April 30	36.5	0.75	36.9	1.65	36.6	3.0	36.6	4.25	36.4	5.5	36.5	7.2
May 1	33.6	(a)	36.8	1.5	36.6	2.8	36.5	3.8	36.4	5.2	36.6	6.8
May 2	28.7	(a)	36.9	1.4	36.8	2.7	36.6	3.8	36.6	4.7	36.5	6.4
May 3	(b)	(b)	36.7	1.3	36.8	2.6	36.7	3.7	36.5	4.7	36.5	6.3
May 5	(b)	(b)	25.1	(a)	36.4	1.5	36.6	3.5	36.6	4.5	36.4	6.2

[a] Acidic.

[b] Cannot be polarized.

TABLE 8.—*Composition of the raw juice, day by day, during the first part of the season.*

[General average: C. Brix, 17.00; per cent polarization, 8.83; alkalinity, 10.0]

Coolie No.	April 30, 1925.			May 1, 1925.			May 2, 1925.			May 3, 1925.			May 4, 1925.		
	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity n / 5.	C. Brix.	Per cent polarization.	Alkalinity n / 5.	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.
1	18.6	11.5		17.4	8.8	9.6	15.96	7.02	7.4	15.2	6.11	8.7	14.91	6.4	5.0
2	14.6	7.0		14.9	11.6	14.5	13.76	4.61	12.6	12.1	2.49	12.9	11.21	3.9	9.4
3	19.0	10.3		18.8	7.5	19.1	15.96	6.18	7.1	13.4	4.06	9.6	14.21	5.4	3.8
4	19.1	13.9		17.3	8.3	7.3	17.06	8.06	15.1	14.5	5.87	4.4	13.41	6.6	16.1
5							18.26	8.21	15.4	19.4	10.45	16.3	17.31	8.0	9.8
6	15.67	7.04		17.4	11.9	8.8	18.76	9.06	17.4	18.3	8.45	15.5	16.50	8.3	6.7
7	16.3	10.6		15.1	6.5	17.2	13.66	5.11	12.1	12.5	4.53	9.0	13.91	6.6	8.0
8	18.1	10.1		16.9	8.1	7.4	19.96	9.89	24.9	17.6	7.66	7.4	17.01	8.1	8.3
9	16.2	9.1		18.3	8.9	16.3	17.86	9.00	16.3	17.3	8.44	11.2	15.61	7.4	2.1
10	17.1	10.8		18.0	11.7	11.2	15.16	8.08	(a)	18.2	9.00	13.7	17.81	7.8	16.4
11							17.76	10.37	10.1	18.7	9.08	19.7	17.11	8.8	6.4
12	20.1	15.7		18.8	11.0	5.1	21.06	11.43	23.0	19.2	10.76	15.6	20.11	12.5	10.9
13				16.1	8.9	2.9	19.06	10.66	21.9	20.3	12.09	18.5	18.21	9.9	6.2
14							20.26	12.76	14.0	19.4	10.55	11.3	18.71	10.6	3.1
15	17.4	11.5		17.1	10.2	4.4	18.56	10.10	15.1	16.9	6.31	17.2	17.91	9.0	11.6
16	20.6	12.5		19.3	9.8	17.7	20.26	10.49	28.5	20.4	11.56	27.2	19.01	11.4	17.8

Coolie No.	May 5, 1925.			May 6, 1925.			May 7, 1925.			Average.		
	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.
1	15.4	8.3	0.6	14.7	5.23	(a)	17.64	7.63	16.5	16.23	7.62	6.8
2	12.8	6.6	0.5	10.0	2.86	3.8				12.77	5.55	8.9
3	13.6	4.2	(a)	11.01	2.0	(a)				15.14	5.66	6.6
4	15.7	6.9	16.1	16.01	7.75	4.9				16.15	8.20	10.6
5	17.1	7.3	20.7	15.41	7.37	7.8				17.50	8.27	14.0
6	19.5	10.7	18.9	17.71	8.0	3.7				17.70	9.06	11.8
7	13.0	7.5	2.8	15.0	10.5	1.6	12.7	5.52	1.9	14.03	7.11	7.5
8	14.7	6.5	1.4	15.71	6.44	3.2				17.14	8.11	8.8
9	15.5	7.1	3.0	18.11	13.29	(a)				16.98	8.89	8.1
10	17.9	8.3	20.8	17.51	9.07	15.4				17.38	9.25	12.9
11	17.7	8.8	15.1	17.81	9.15	8.6				17.82	9.12	11.9
12	17.2	8.9	2.9	19.41	12.67	6.8				19.41	0.85	10.7
13	18.7	10.3	8.0	17.41	9.02	4.5				18.29	10.15	10.3
14	19.1	11.3	6.9	18.2	14.35	0.25				19.13	11.91	7.1
15	15.4	8.7	1.3	16.01	7.85	(a)				17.04	9.09	8.3
16	16.4	8.1	3.4	19.1	13.81	10.0	19.5	13.4	5.5	19.32	11.38	15.7

TABLE 9.—*Composition of the raw juice, day by day, during the second part of the season.*

Date.	Coolie 1.			Coolie 2.			Coolie 3.			Coolie 4.		
	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.
1925												
May 8	17.2	9.77	(c)	19.9	16.5	2.6	19.2	15.4	2.1	19.5	15.92	2.4
May 9	17.6	12.04	1.5	20.4	15.09	8.4	19.9	16.06	6.3	20.0	14.63	5.7
May 10	16.0	8.63	2.1	10.4	13.99	(a)	18.5	13.84	(b)	19.4	15.87	3.2
May 11	18.29	14.14	1.3	19.39	15.04	0.9	18.39	13.11	do	19.29	13.88	(a)
May 12	17.69	13.21	1.2	19.89	15.90	4.7	18.49	14.42	0.2	19.09	15.80	1.2
May 13	17.7	12.68	1.2	20.0	16.17	3.1	18.7	14.65	0.4	18.5	12.62	1.1
May 14	18.11	10.7	10.1	18.81	13.86	10.0	18.01	15.08	2.95	17.71	13.54	5.6
May 15	18.5	10.83	7.9	20.6	12.76	10.0	19.3	11.66	6.0	20.2	13.56	5.6
May 16	16.82	10.5	0.4	19.83	14.14	4.0	18.52	15.54	(a)	19.42	15.67	2.0
May 17	16.52	8.42	1.0	20.02	11.73	4.1	19.62	12.0	5.5	20.12	13.47	4.6
May 18	18.47	10.40	4.7	19.64	13.16	4.6	19.84	11.82	7.7	20.64	13.29	2.8
May 19	19.7	11.17	9.1	20.1	13.47	5.5	20.0	11.97	8.3	21.0	13.80	7.9
May 20	19.9	11.97	8.2	19.4	10.16	9.3	19.9	12.21	8.0	21.0	13.18	7.3
May 21	19.4	11.12	8.8	21.2	11.15	15.3	20.24	11.63	8.7	21.32	12.81	12.1
May 22	18.7	9.71	5.0	20.7	12.86	11.3	20.5	11.66	10.3			
May 23												
May 24	18.48	10.83	1.3	21.08	13.7	4.3	19.46	12.38	3.0	21.58	14.01	3.6
May 25	18.6		7.1	20.9	12.5	12.3	18.4		6.4	19.4		2.8
May 26	17.5		3.7	19.5		6.6	18.4		4.2	21.2		20.7
May 27			9.1	20.51		13.6	19.61		8.3	21.61		21.0
May 28	18.5		6.4	21.8	11.97	20.2	20.4		8.9	22.9		22.2
May 29	20.2	11.25	14.4	20.7	12.19	13.4	20.2	11.73	11.0	13.13	13.13	6.3
May 30	19.61	12.72	12.8	20.51	13.48	13.4	19.31	12.09	8.1	21.81	13.02	15.7
Average [d]	18.27	11.11	5.3	20.15	13.53	8.1	19.31	13.12	5.3	20.28	14.01	7.3

Date.	Coolie 5.			Coolie 6.			Coolie 7.			Coolie 8.		
	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.	C. Brix.	Per cent polarization.	Alkalinity.
May 8	18.4	14.6	1.9	19.0	13.9	0.7	15.9	10.7	6.4			
May 9	17.4	11.46	1.1	18.4	12.24	3.1	17.6	12.39	7.1	22.2	18.38	7.0
May 10	17.0	8.3	7.6	18.1	14.6	2.9	19.1	9.89	7.8	22.1	12.44	14.5
May 11	17.59	14.92	0.8	19.19	15.51	1.6	17.49	14.29	2.3	18.9	9.45	[c]
May 12	17.09	15.88	0.4	18.69	15.15	3.2	17.59	13.65	2.7	20.0	14.92	6.0
May 13	17.4	11.51	0.5	19.3	15.25	2.2	17.6	13.26	1.1	19.25	11.56	1.8
May 14	17.01	12.85	2.2	17.71	11.97	9.1	16.61	10.75	10.1	19.37	11.66	9.2
May 15	18.2	11.58	6.5	20.6	13.36	10.0	18.7	11.65	9.4	19.67	12.05	4.4
May 16	18.59	11.27	8.3	19.32	12.24	4.2	18.52	11.11	8.7	20.9	12.41	13.2
May 17	17.62	10.83	3.7	20.92	12.26	12.8	18.02	11.58	5.8	21.24	11.49	14.2
May 18	18.94	11.83	7.6	21.64	12.79	14.0	18.54	11.37	8.3	21.9	12.64	26.0
May 19	18.6	12.0	7.7	21.5	13.29	17.0	18.1	11.48	7.9	20.8	12.60	12.6
May 20	18.5	12.59	7.2	21.5	12.19	17.1	18.2	11.48	7.9	21.0	12.17	13.6
May 21	18.14	11.00	5.4	20.9	13.27	13.7	18.7	10.68	10.1	19.54	12.0	4.3
May 22	19.4	12.05	12.2	21.5	12.04	16.8	18.4	11.02	6.1	21.01	11.86	15.7
May 23	17.64	10.14	2.4							21.96	12.07	21.0
May 24	18.96	12.36	4.8	20.98	12.17	13.1	19.08	12.07	4.0	19.68	11.12	6.1
May 25	17.7	10.83	7.4	20.11		14.5	19.1		14.6	19.8	12.8	13.8
May 26	18.0		11.5	20.6		18.0	19.0		10.5	19.21	10.45	9.2
May 27	18.71		12.5	21.11		22.0	18.71		7.3	20.82	11.8	15.4
May 28	20.0	10.28	20.9							20.6	11.71	11.9
May 29	18.6	11.07	5.9							19.1	10.9	3.8
May 30	17.31	11.21	7.2							21.11	11.29	13.2
Average [d]	18.12	11.73	6.3	20.00	13.26	10.3	18.16	11.71	7.3	20.46	12.19	10.81

[a] Neutral. [b] Slightly acidic. [c] Acidic. [d] General average: C. Brix, 19.24; per cent polarization, 12.58; alkalinity, 7.6.

In addition to the fields that were already being tapped when we arrived at Semawang, a new field was started by Maximo, a Filipino tapper in our party. He started the preliminary treatment shortly after our arrival, and three weeks afterward, or more exactly May 9, he was delivering juice to the factory as coolie 8 (see Table 9). He used only lime milk of 50° Brix without any bisulphite. The results of experiments on collection are given in Tables 1 to 5.

Tables 1 and 2 give the results with three different methods of collection; namely, the float method, the smearing method, and the funnel method. In each case three stands were taken. In order to determine the extent to which juice is preserved by each method, we took test-tube samples in the afternoon just before putting on the tuquils, and in the morning after removing the tuquils. The test-tube samples were preserved with toluene, brought to the laboratory within an hour, and analyzed immediately. The average of the two samples, which were numbered 1 and 2, give, approximately, the analyses of the total flow for the period covered. We have noticed that the morning flow contains lower sucrose than the afternoon flow.

A comparison of the results given in Tables 1 and 2 indicates that the smearing method gives slightly better results than either the funnel or the float method. The results also indicate that the tuquil juices collected by any of the three methods are consistently lower in sucrose content than the test-tube samples. This is to be expected, as both the lime added to the juice and the gummy matter that is present in the tuquil samples but not found in the test-tube samples, as well as slight fermentation in the former, tend to lower the percentage of sucrose in the juice.

Table 3 gives the results Wood obtained with closed tin tubes, first using no lime, then adding a gradually increasing amount of lime.

Table 4 gives the results obtained with the cup method of distributing lime. In this experiment, which could be run only three days because of the lack of lime, lime paste was used in the cup. The idea was to use the cup without renewal of the lime, as long as it lasted, thus saving the labor incident upon the cleaning and smearing of the tuquils in the original Gibbs method. As our time and the laboratory equipment were needed in the chemical control of the factory, the experiment was discontinued. The results obtained seem to warrant further experimentation.

Table 5 gives the results of collection of sap with the closed tin tubes compared with the collection with bamboo tuquils. Three coolies were each given about thirty closed tins and were instructed to bring the juices from the tins and from the tuquils separately. Both the tuquils and the tins were smeared with lime-bisulphite mixture. At the time this experiment was being conducted, we ran out of filter paper and some of the samples could not be analyzed. The results of coolie 8 seem to indicate a slight advantage in favor of the tin.

To gain some idea of the variation in composition of the sap from different stands, test-tube samples were collected from a number of stands in different fields. The juices were preserved with toluene as in experiments 1 and 2 (Tables 1 and 2). The results are given in Table 6, and show a general average for test-tube samples as follows: Refractometer solids, 20.3; per cent polarization, 17.04; refractometer purity, 83.94.

It has been remarked that as a rule test-tube samples give higher per cent polarization than tuquil samples and that several factors contribute in lowering the per cent polarization in the latter. How far the sucrose content of the tuquil samples can be made to approach that of the test-tube samples will be largely determined by the experience and care of the collectors and by the adoption of a reliable device for the uniform distribution of lime.

Table 7 shows the results of an experiment to determine the lowest alkalinity that will inhibit decomposition of the sucrose in the sap. The sap used in this experiment was collected directly in clean bottles containing a few drops of toluene. Equal amounts of the thoroughly mixed sap after the removal of the toluene were placed in clean bottles and limed to different alkalinities. It is interesting to note the gradual decrease in alkalinity from day to day, at first only in the samples of low alkalinity, but later even in those with greater alkalinity. Wells and Perkins(4) could preserve sap in strongly alkaline (54 cubic centimeters 0.1 *N* cubic centimeter per 10 cubic centimeters juice) condition without apparent decomposition for as long as one month. Some decomposition may have taken place in the sap, which may have escaped notice, as juices kept by us under their conditions became dark in the course of several days and showed a slight decrease in polarization. As they could obtain white sugar from the sap kept in strongly alkaline condition for a month, the slight decomposition and the deeper color did

not evidently affect the refining quality of the juice. Our experience in Semawang confirms this finding.

Tables 8 and 9 give the composition day by day of the juices collected by the tappers; Table 8 for juices collected during the first part of the season, when the smearing of the tuquils was done by the tappers in the field and when some Chinese coolies were employed; and Table 9 for the second part of the season, when seven Malays and Maximo were employed. The tuquils were then smeared with lime milk in a central station, using a mixture of lime and sodium bisulphite.

No sugar could be made from the juices reported in Table 8. The blank spaces in Table 9 correspond to days when for lack of lime we had to discontinue collection, awaiting arrival of order from Sandakan.

THE MANUFACTURE OF SUGAR FROM THE SAP

The first experiment we ran on the manufacture of sugar from the sap was in the muscovado plant. The juice was evaporated in open pans to a concentration of not over 40° Brix with the purpose of reducing the bulk and thus saving in transportation expenses. Three daily collections were boiled.

A comparison of the purity of the sirup with that of the clarified juice, reveals a great drop in the purity when the juice is boiled in open pans. Coincident with the destruction of sucrose, there was also great darkening of the solution. After the first trials, it was evident to us that sirup of good quality could not be obtained in this way, and that the method destroyed the refining quality of the nipa sap, which is its greatest asset and advantage over the sugar-cane juice.

For the following reasons it was not considered worth while to continue the experiments in the muscovado plant.

1. Transportation by water is relatively cheap, and the saving in handling sirup instead of the sap will be more than offset by the disadvantages.
2. Nipa sap can be preserved efficiently by heavy liming.
3. Heavy liming is not harmful to the refining qualities of nipa sap.
4. Sirup of 40° Brix may still be subject to fermentation after several days' standing.
5. No little investment would be required for the open-pan evaporators.
6. Such method will place in the hands of unskilled labor the carbonation of the sap, an important operation on which the quality of the sugar largely depends.

7. In a muscovado plant, only a crude carbonation apparatus could be used. In such apparatus, the mechanical loss through the formation of foam is very high.

In the centrifugal plant the simplest method of treating the juice was adopted. The juices, after being weighed, sampled, and analyzed for sucrose, were received in a tank. From the reservoir tank the juice was pumped to the carbonating apparatus made from 50-gallon drums and galvanized iron pipes, as shown in fig. 3. The carbonated juice was heated to boiling and passed through continuous settling tanks to the clarified-juice tank from which it was taken into the evaporator and boiled to sirup. The sirup was boiled as in cane-sugar manufacture.

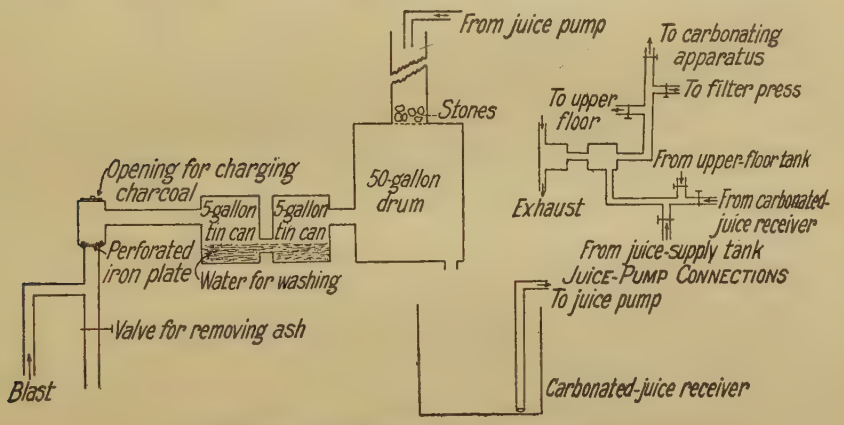

Fig. 3. Diagrammatic arrangement of the carbonating apparatus.

The first run produced a mass that was badly foaming, very viscous, and could not be boiled to the graining point even after fifteen hours. Laboratory examination revealed that it contained a heavy precipitate of gummy matter which would not settle except by the addition of lime. Samples of juice were then taken from the laboratory and treated with different amounts of lime. In juices of alkalinity less than 27 cubic centimeters of 0.5 *N* per 10 cubic centimeters juice, carbonation to neutrality failed to remove all of the gummy matter. Some form of it remained in colloidal solution and would not settle or separate out even when filtered until after the juice was concentrated to massecuite. Solutions containing a certain amount of these gums when boiled with small amounts of calcium carbonate developed color and the characteristic odor of nipa juice. When, however, the juice was limed to an alkalinity of 27 cubic centi-

meters 0.5 *N* per 10 cubic centimeters juice, and the gummy matter filtered or strained out, and then the strained juice carbonated to neutrality and filtered, the concentrated filtered juice gave a water-clear, pale yellow liquid that boiled readily with very little foaming. Before adopting the method suggested by our laboratory experiment, we tried once more to carbonate juices of low alkalinity. This time care was taken to allow the clarified juice to settle longer and to send only clear juice to the clarified-juice tank. This second trial resulted in a thick mass-secuite and a very low yield of sugar. The same difficulties were encountered as in the first trial.

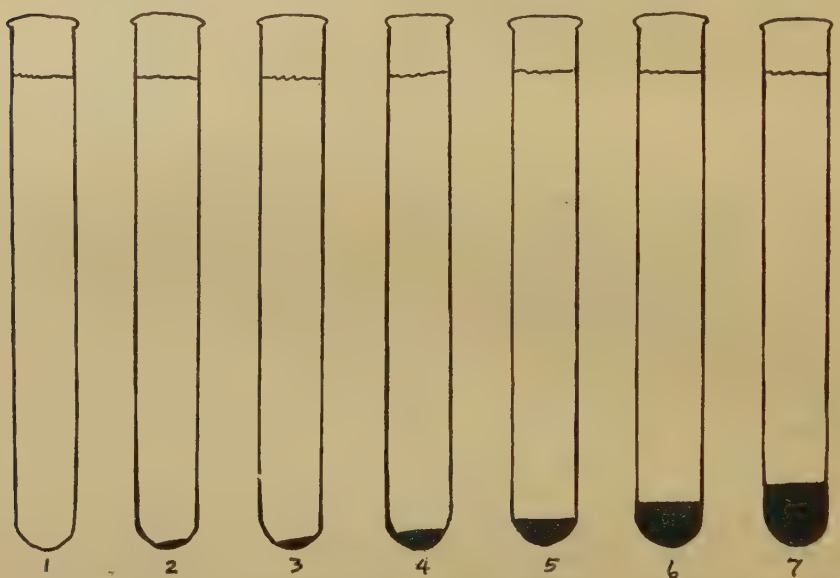

FIG. 4. Relative amount of precipitate formed upon the addition of a graduated increasing amount of lime to nipa sap.

The following method suggested by our laboratory experiments was adopted. The juice, after being weighed, was placed in drums and treated with lime to an alkalinity of 27 cubic centimeters 0.5 *N* per 10 cubic centimeters juice. It was allowed to settle for several hours and syphoned into a tank from which it was taken into the carbonating apparatus. Carbonation was accomplished by gradually warming the juice as it was being neutralized by the carbon dioxide. When the neutral point was reached, as indicated by the effect of a drop in phenolphthalein solution contained in a test plate, the liquid was brought to the

boiling point and boiled for about two minutes. Then the juice was pumped to a reservoir on the upper floor and allowed to fall by gravity through the filter press. The juice filtered very easily, flowing as if there was no filter cloth in its way; and the precipitate formed a hard granular cake, which did not readily clog the filter cloth. The filtered juice was water-clear, pale yellow, and practically free from gum. The process is represented diagrammatically in fig. 5.

In order to confirm the good effect of heavy liming, we tried once more to carbonate juice with low alkalinity, this time the whole of the carbonated juice was filtered. A difference in

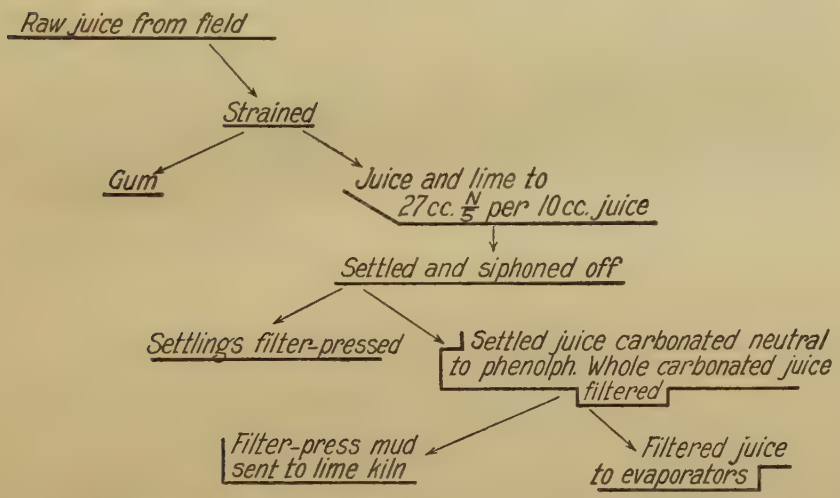

FIG. 5. Method for the manufacture of sugar from nipa sap at Semawang.

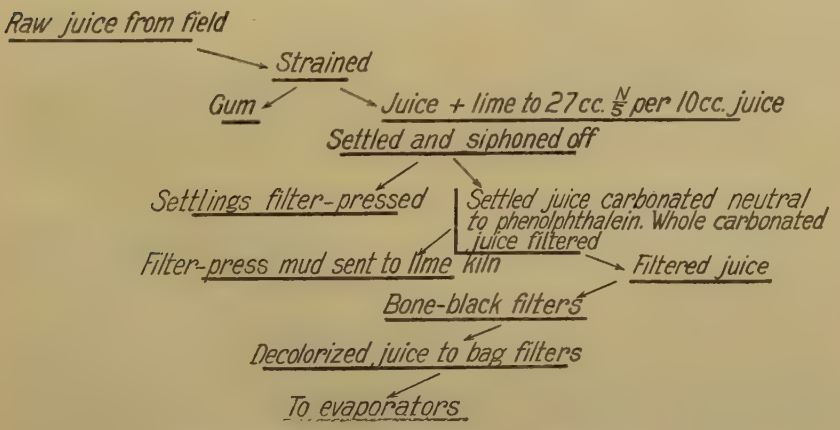

FIG. 6. A proposed method for the manufacture of refined sugar from nipa sap.

behavior between heavily limed and lightly limed juice again became evident on filtration. While the heavily limed juice filtered readily, giving a granular, solid, easily handled precipitate, the slightly limed juice was hard to filter and gave a cloudy filtrate, and slimmy precipitate which clogged the filter in a short time.

We ran two strikes with heavily limed juice, two with slightly limed juice, and a mixed massecuite. In every case the noted difference in behavior between the slightly and the heavily limed juice was observed. Moreover, the sugar made from the heavily limed juice was decidedly whiter than that from the slightly limed juice. The best sugar was made from strike 3. In this case, the cold juice was carbonated until neutral, then it was heated to boiling, boiled for two minutes, and filtered. Table 10 gives the balance of recovery and losses. Table 11 is the daily raw juice weight record. Table 12 is the final run report. Table 13 gives the proximate analysis of the white sugar after it was first dried in the sun. This analysis was made at our laboratory in Los Baños.

TABLE 10.—*Balance recovery and losses for the whole period from May 11 to June 3, 1925.*

Recovery and losses.	Debit.		Credit.	
	Kilos polarization.	Per cent.	Kilos polarization.	Per cent.
Entered in raw juice	431.21	100		
Recovery:				
152.3 kilos sugar in bags at 97.4 polarization			148.34	
15.4 kilos available commercial sugar in A molasses.			14.96	40.67
12.4 kilos available commercial sugar in B sugar.			12.07	
Losses:				
In settlings			12.15	2.82
In filter press cake			3.67	0.85
In final molasses in cans			38.21	8.86
In available final molasses from the A molasses.			59.46	13.79
Mechanical losses in carbonation			80.84	18.75
Mechanical losses in pans and by inversion			61.51	14.26
Total	431.21	100	431.21	100.00

Text fig. 7 represents in diagrammatic form the distribution of the common salt in the various sugar-house products. In the manufacture of sugar from nipa sap special attention seems to be demanded by the presence of sodium chloride in the juice

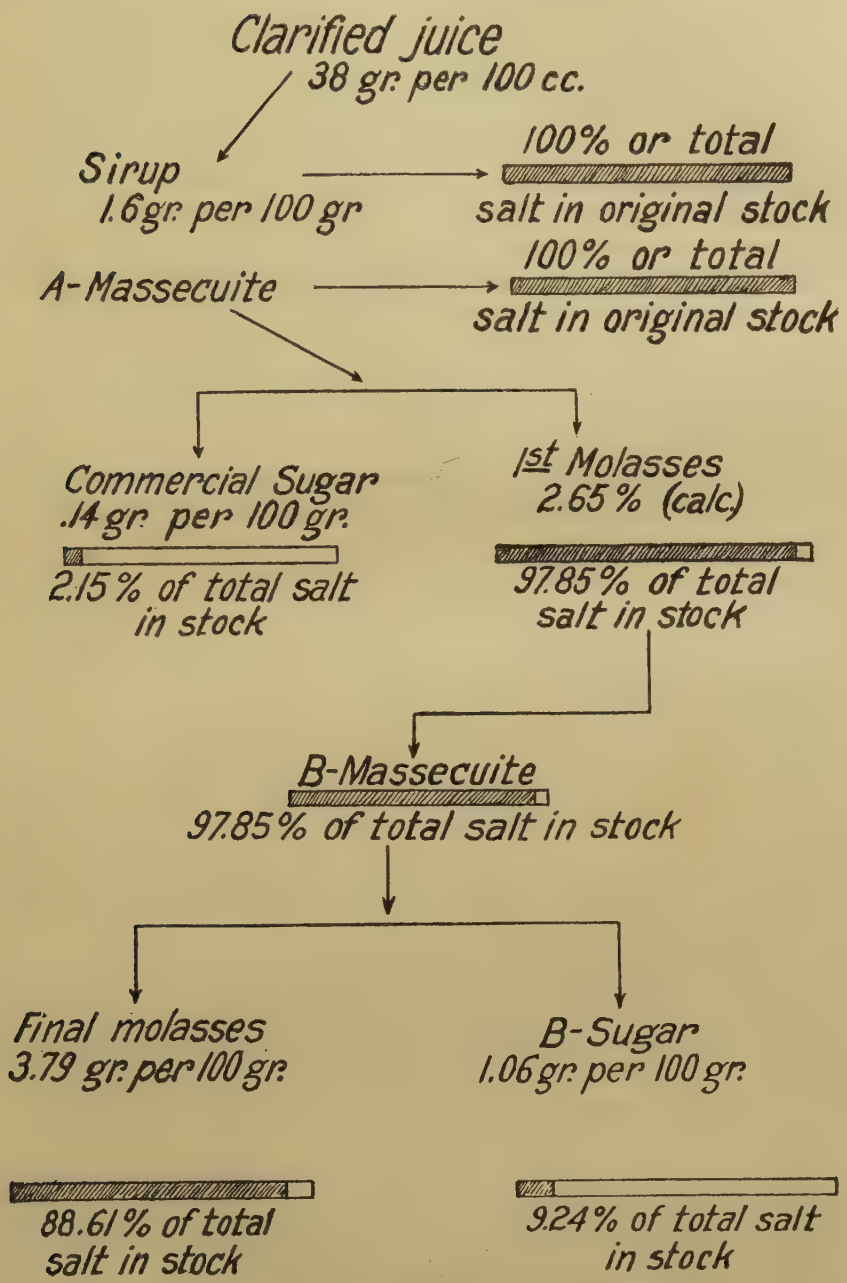

FIG. 7. Salt distribution in the manufacture of sugar.

since this is far above the amount ordinarily found in saccharine juices from other plants. Nipa sap ordinarily contains about 0.37 per cent of sodium chloride, and upon concentration and

crystallization of the sugar, the mother liquor, from which the commercial sugar is separated, is practically a saturated solution of common salt. It is, therefore, not surprising to find that the sugar made may contain from 0.2 to 0.5 per cent salt depending on the grade. Some of the sugar contained as low as 0.15 per cent;[2] this shows that most of the salt may be washed out from the sugar. As the B sugar contains more molasses and therefore a higher percentage of sodium chloride (in one of the B sugars as high as 1.3 per cent), special attention should be paid to its return to the process. When B sugar of such sodium chloride content is used for seed or remelted in the clarified sap, the amount of sodium chloride may gradually increase in the subsequent massecuites and, therefore, in the commercial sugar. If refined sugar is made directly from the nipa sap, returning the B sugar to the process may not be desirable at all. It may be more advantageous to sell it as muscovado sugar.

CHEMICAL-CONTROL PROBLEMS

After an experience of a few days in the analysis of nipa sap it became apparent that Horne's dry lead subacetate method, the most convenient and rapid method universally used in cane-sugar factories, is of no value in the polarization of nipa juices. The lead subacetate, while clarifying the juice to a lightly colored liquid, produces a fine precipitate which passes through the filter paper readily and makes the filtrate unsuitable for polarization. We found that lime in the form of dry calcium hydroxide is the best clarifying agent for nipa juices. One objection to the use of calcium hydroxide in clarifying saccharine juices is its pronounced effect in depressing the polarization of sucrose by the formation of calcium saccharate, a compound with much lower optical rotation than free sucrose. This effect of calcium on the polarization of sucrose may be observed in the increase in purity of the carbonated juice over that of raw juice. While it is possible to determine the per cent polarization in the raw juice by taking the normal weight and removing the lime by a carbonate solution, such a method does not lend itself to the rapid work demanded in the control of incoming juices, in the regular process of manufacture. It is thus apparent that methods of analysis for rapid control work especially adapted

[2] Some of the white sugar analyzed at Los Baños gave as low as 0.06 per cent sodium chloride.

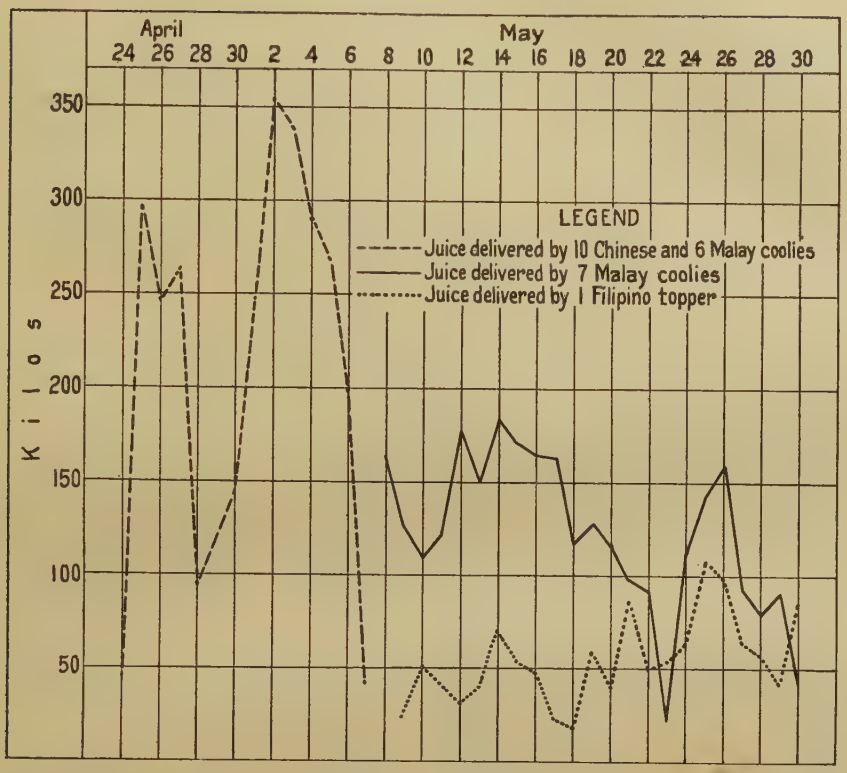

FIG 8. Daily juice weights record.

to nipa juice must be devised and tables made similar to those for Horne's dry lead subacetate method for cane juices.

Although the polarization of raw juices is the best criterion on which to judge the acceptability of juices that are turned in by each coolie, one can realize the impossibility of using it where thousands of coolies are employed in sap collection as in large-scale manufacture of sugar from nipa. Emperical methods of judging the acceptability of juices, which of course may subsequently be supplemented by polarization of group samples, must be devised. One such method is the determination of the alkalinity of the juice. In the course of our work at Semawang, we found that juices which underwent partial fermentation were only slightly alkaline or acidic, and we adopted the scheme of taking a definite volume of the juice collected by each coolie and adding it to a test tube containing a measured amount of acid and a few drops of phenolphthalein. Juices that did not

show any color were set aside. These were then sampled and analyzed. If the percentages of sucrose were found to be above 10, they were accepted, if below, discarded. After a few weeks of experience in judging juices, and after eliminating the possibility of coolies adding salt water, one can judge whether juices are good or poor or very largely fermented by their appearance and formation of froth; foaming, milky surface, and bubbling of the liquid indicating deterioration of the sap.

COMMENTS AND DISCUSSION

Collection of sap.—The collection of the sap should be considered the most important stage in nipa-sugar manufacture since the quality of the sap collected will determine whether the industry will be a success or a failure. A complete understanding of the problems bearing on collection is important.

Gibbs, after careful study of the nipales around Manila Bay, estimated that 30,000 liters of sap may be obtained per hectare of 750 producing stands per season of ninety days. This is at the rate of 40 liters per stand per season of ninety days, or about 0.44 liter per day. Out record at Semawang tends to show that this estimate is also applicable to the nipales there. Table 11 gives the daily weight of juices during the whole period of collection. Disregarding the first part of the period, from April 24 to May 7, and only taking into consideration the period from May 8 to May 30, we find that during this period the seven Malay coolies delivered 2,828.8 kilograms of sap. This amount collected from 240 trees shows, therefore, a rate of production of 0.513 kilogram per stand per day. From May 9 to May 30, coolie 8 turned in 1,182.5 grams. He was handling 110 trees. His record follows: Days of collection, 21; trees tapped, 110; sap collected, 1,182.5 kilograms; sap per tree per day, 0.513 kilogram.

It is to be noted that the Malay coolies were collecting sap from stands that had been tapped for over three months, while Maximo was tapping stands that still had very long stumps, and which one may consider to be at the beginning of the season.

The Malay coolies used in the collection of sap were under contract with the Semawang alcohol plant at 50 cents, Bornean money, a day. They were handling about 34 nipa stands each and were putting in about three hours work a day. The superintendent of Semawang asserted that he did not know of any way to make the Malays handle more than that number of

TABLE 11.—*Daily raw juice weight record.*

Date.	Kilograms.	Date.	Kilograms.
April 24	45.4	May 26	158.7
April 25	295.7	May 27	93.4
April 26	246.1	May 28	79.4
April 27	266.2	May 29	91.1
April 28	94.5	May 30	42.3
April 30	145.2		
May 1	244.6	Total	2,828.8
May 2	353.3	May 9 [b]	24.3
May 3	337.2	May 10	50.1
May 4	290.3	May 11	(c)
May 5	267.3	May 12	32.0
May 6	195.7	May 15	39.1
May 7	40.9	May 14	69.0
		May 15	54.6
Total [a]	2,822.4	May 16	48.9
May 8	164.1	May 17	24.2
May 9	127.0	May 18	18.5
May 10	110.2	May 19	58.7
May 11	122.5	May 20	41.6
May 12	178.0	May 21	86.4
May 13	149.9	May 22	50.5
May 14	182.6	May 23	54.2
May 15	171.0	May 24	63.0
May 16	165.0	May 25	107.9
May 17	162.7	May 26	99.0
May 18	116.6	May 27	64.0
May 19	128.2	May 28	59.4
May 20	117.2	May 29	42.0
May 21	98.3	May 30	85.1
May 22	93.5		
May 23	22.4	Total	1,182.5
May 24	110.8	Grand total	6,833.7
May 25	143.9		

[a] The record for May 8 to 30 is for seven Malay coolies.
[b] The record for May 9 to 30 is for coolie No. 8.
[c] Discarded.

trees. They were unable to obtain satisfactory results with the Malay and Chinese coolies for work in nipa swamps.

The Filipinos, who previous to our arrival worked at Semawang, were turning in several times the amount of sap collected by the Chinese or Malay coolies. Mr. Wood calculated that a Filipino tapper may turn in as much as 90 gallons of sap for alcohol manufacture a day. This would hardly be possible for sap for sugar manufacture, because of the necessity of cleaning the stumps and frequently changing the lime in the tuquil and

the tuquil itself. As the yield of sap per tree varies in different fields, and from day to day, and with the advance of the season, a safer way of estimating the average amount delivered by one tapper per day would be on the basis of number of stands that can be handled by the tapper, rather than by the amount of sap delivered as determined in an observation lasting only a few days. Many observations have been made elsewhere of the variation in flow of sap from nipa stands and a general average per stand to cover a 90-day season given.

Other factors besides the variation of flow of sap must be taken into consideration. In collection on a commercial scale, tappers should be instructed to throw away partly fermented sap; some sap will be spilled in handling, or lost through the work of monkeys or otherwise. All of these must be taken into consideration. A safe and conservative estimate may be made only by carrying out the observations with a number of coolies handling several hundred trees throughout one nipa season and under actual working conditions.

Other factors that tend to lower estimates obtained in experiments in a grove not systematically developed for collection on a large scale are lack of trails and of a system of canals, and the fact that coolies still have to carry the sap to the plant, and lack of organization and disregard of the principle of the division of labor. Tappers who do nothing but clean and tap stands, working in coöperation with another gang whose sole duty is to collect and deliver sap to storage stations, will undoubtedly be able to handle in one day more than the estimate of 210 trees used in this report.

The figures given by Gibbs and those obtained by us at Semawang agree within narrow limits. For purposes of collection, we are assuming an average of 45 kilograms of sap per stand per season of ninety days.

The average sucrose content of sap collected by the coolies was 12.58 per cent. This is in agreement with the findings of Eaton and Dennete,(6) who recommend that, for purposes of sound estimate, 12.5 per cent sucrose in the sap should be used. In making our estimates, we also use 70 per cent for boiling-house recovery (see Table 12).

Considering the fact that the quality of sap depends entirely on the interest of the tapper in his work and considering the kind of labor used in nipales, we believe that the only way to insure good quality of sap is by adopting the share system in

TABLE 12.—*Final run report; June 3, 1925.*

	Actual.	Calculated assuming 70 per cent recovery, and 4 per cent mechanical loss.[a]
Juice entered into manufacture:		
Juice delivered ..... Tonnes	3.4422	3.4422
Sucrose ..... Per cent	12.53	12.53
Juice per ton sugar ..... Tons	22.586	11.323
Sugar per ton juice ..... Piculs	0.698	[b] 1.39
Sugar manufactured:		
Polarization ..... Per cent	97.4	99.0
Moisture ..... do	----------	[c] 0.18
Excess moisture ..... do	----------	11.38
Clarity	----------	(d)
Ash ..... do	----------	[c] 0.19
Tonnes	0.1523	0.3040
Lime used:		
Calcium oxide (CaO) per ton juice ..... Kilos	130.0	130.0
Press cake:		
Juice ..... Per cent	3.3	----------
Polarization ..... do	3.2	3.2
Settlings:		
Juice ..... do	2.9	2.9
Polarization ..... do	12.2	12.2
Final molasses:		
Brix	83.64	83.64
Gravity purity	57.8	57.8
Total produced ..... Tons	0.076	0.231
Per ton sugar ..... Gallons	[e] 202.4	139.7
Sirup:		
Brix	60.8	60.8
Apparent purity	80.6	80.6

[a] The boiling-house recovery of 70 was assumed on the following consideration. The purity of the best final molasses we obtained was 57.8. This was boiled from a molasses of rather high purity and which came from the juice that was slightly limed. The B molasses we obtained from the heavily limed juice had a purity of 61.0. We could expect a purity of 50 in the final molasses obtained from this A molasses. Pratt and coworkers were actually able to obtain final molasses of 50 purity from nipa sap. The theoretical recovery for sirup of 80 purity and final molasses of 57 is 68.7. The theoretical recovery on sirup of 80 and final molasses of 50 is 76.6. We arbitrarily took 70 lying between these two figures as a conservative percentage of recovery to be used for purposes of calculating probable returns.

[b] The piculs per ton juice was figured on a sugar polarization of 99.0, the polarization of sugar after drying in the sun.

[c] The samples of sugar were analyzed at Los Baños after they were dried in the sun.

[d] Water clear.

[e] Includes available B molasses in A molasses in stock.

collection. Our experience with Chinese coolies in Semawang, though brief, has convinced us of the advisability of adopting this method. In central practice in the Philippines, it has been found that the fifty-fifty contract is a satisfactory distribution

of sugar, and is most generally used. For purposes of calculation, we, therefore, adopt the fifty-fifty contract.

Calculation.—Forty-five kilograms of sap at 12.5 per cent sucrose, 70 per cent boiling-house recovery, will give 3.94 kilograms of sugar; 50 per cent of this is 1.97 kilograms of sugar per season per tuquil. This is white sugar at an estimated value of 5 cents a pound or 22.4 centavos per kilogram. Therefore, the value of the sugar corresponding to one tuquil per season is 44.34 centavos.

In a series of observations made by one of us in the course of our work, we found that it took, on the average, two minutes per stand to collect sap, wash the stand, tap, and attach the new tuquil. Thus, a man working seven continuous hours will handle 210 stands in one day. There are laborers who can handle more, and others, less, but we can consider 210 a fair and conservative average; 210 stands at 43.34 centavos will give the tapper 91.40 pesos in ninety days or at the rate of about 1 peso per day. This will prove attractive to Filipino laborers, provided the cost of lime and other extra expenses are not added. If the tuquils used are made of bamboo, the laborers themselves can make them. The bamboo tuquils cost 3 to 3.5 centavos and if cared for properly will last indefinitely.

We believe that the bamboo tuquil is not likely to be replaced by more elaborate containers. Tubes made of tin or any convenient material different from bamboo would probably cost not less than 30 centavos, 70 per cent of the return per stand. Those used at Semawang cost 40. Even assuming that the life of the tuquil is four years (if it is made of tin it may not last two years) the increased return will not compensate for the cost. On the other hand, the cup shown in fig. 1, which would materially reduce the consumption of lime can be made from a discarded food tin at a cost of less than 5 centavos.

Summary.—Yield of sap per stand per season of ninety days, 45 kilograms; sugar per stand per season (12.5 per cent sucrose in sap, 70 per cent boiling-house recovery), 3.94 kilograms; share of the collector, 50 per cent; value of collector's share at 5 cents a pound (white sugar), 44.34 centavos; 210 trees per season of ninety days will, therefore, return 91.40 pesos, or about 1 peso per day.

Amount of lime and bisulphite needed.—Trials with the smearing method give on the average a dry-lime consumption per tuquil per day of 100 grams. This is at the rate of 19.45

per cent of the weight of the juice. Only 1.5 to 2 per cent is left in the sap. The rest goes to waste. Considering that in the carbonation process used in twenty factories in Java the amount of lime required is only 3 per cent of the weight of the cane, the great necessity of improving collection with the view to reducing the amount of lime used will be realized.

In addition to lime, and during the last weeks of collection, sodium bisulphite must be used. With the smearing method this will amount to about 8 grams per tuquil at a cost of about 0.8 centavo. With the cup method this may be reduced to 2 grams per tuquil at a cost of 0.2 centavo.

Summarizing, it may be said that any improvement in the container for the sap must be inexpensive, of the simplest kind, and capable of adjustment in a few seconds.

In reducing the amount of lime used in collection, the tendency should be to cut down the waste and not the amount that actually goes into solution in the sap. The best preservative for the sap is strong alkalinity. Table 7 shows that an alkalinity of less than 0.4 gram calcium oxide (CaO) per 100 cubic centimeters allows the juice to decompose gradually, but that an alkalinity close to 1 per cent will preserve the juice for many days. For best defecation, an alkalinity of 1.5 per cent is required. The juice may be kept at an alkalinity of 1.51 per cent for many days without any danger. The alkalinity obtained in the smearing method as shown in Tables 8 and 9 is only around 0.7 per cent so that sap collected by this method had to be treated with more lime.

The possibility of keeping strongly limed sap without deterioration for many days has an important bearing in collection, and may avoid for the nipa-sugar industry many of the vexing questions that are inevitable in the harvesting of sugar cane. To simplify collection, nipa groves may be divided into districts which may be provided with large storage tanks for sap. The sap may be taken to the factory after a sufficient amount has accumulated.

Sampling stations.—From each district samples of sap must be collected and analyzed for sucrose and alkalinity. The analyses serve as checks on the work of groups of coolies in the field, and for purposes of sugar distribution.

Liming stations.—Stations where lime milk may be prepared and where tuquils may be cleaned and smeared with lime, should this method be adopted, will be necessary during the first days

of the enterprise and wherever inexperienced workers are used. Standardization of lime milk used, and of the lime-milk-bisulphite mixture, will be important.

System of trails.—To facilitate the work of coolies, a system of trails in groves on high river banks or a system of canals in groves on low river banks will be necessary.

The use of pipes in delivering juice to the factory will, in our opinion, be much more expensive than transporting the juice by water. Also, when juices are not limed to a point where the gums contained in the sap are completely precipitated, and if they are not strained out, there will be fouling of the pipes which will be sufficient reason to discard the possibility of their use.

Handling of incoming juices in the factory.—Text fig. 6 shows in diagrammatic form a process of manufacture that we would recommend for nipa sap. The juice may be stored in tanks, of which there must be several in the factory, and is sampled and analyzed for sucrose and alkalinity, and measured or weighed for the control record. After being weighed and measured the juice is strained through fine metallic strainers provided with automatic scrapers. This straining is necessary to remove the gelatinous gummy matter which ordinarily accompanies the sap and, if not removed, may give greater color to the juice treated with lime to strong alkalinity. The strained juice is limed to 27 cubic centimeters 0.5 *N* per 10 cubic centimeters juice, then settled or immediately filter-pressed, the filter-press juice being sent to the carbonation tanks. It is essential to provide the carbonation tanks with tall sides as the juice foams badly on carbonating. The juice must be carbonated in the cold, and as soon as it becomes neutral to phenolphthalein, it must be heated to boiling and boiled for one to two minutes. The filter-press cake may then be washed sparingly with water and the washings used in slaking the lime, a practice which will help reduce the amount of water to be evaporated. Nipa sap treated in this way is practically free from gum, and may be passed through bone-black filters, and then through bag filters, for the direct production of refined sugar.

In designing plants for work with nipa sap, the most efficient vacuum pumps should be used since high vacuum is essential in boiling both the thin juices and the sirup. Other equipment for the handling of refined sugar, such as the granulator, must naturally be included in the plant.

Carbonating tanks.—The alkalinity of the sap for best defecation is about 1.51 per cent calcium oxide by weight, which is approximately the same as that in sugar-cane juice for factories using the carbonation process. Therefore the same standards as to size of tanks, etc., may be used.

Lime kilns.—When the smearing method is used the lime kilns must be of such size as to supply 20 per cent of dry calcium oxide on the weight of the sap. If the cup or a similar method is used, the amount of lime may be reduced to 5 per cent. Deerr [3] estimates the amount of lime used in carbonation to be 3 per cent on cane. It may be roughly stated that the capacity of lime kilns for nipa sap using the cup method should be from $\frac{4}{3}$ to $\frac{5}{3}$ times that for sugar cane.

Filter presses.—In a test at Semawang we obtained the following data: Filtering area of press, 5.47 square feet; carbonated sap with the precipitate passed in one hour, 305.1 kilograms. This gives a filtering area of 17.9 square feet per ton hour. The filtering area for settlings would be about the same so that the total filtering area per ton-sap-hour would be about 35.8, which is one-third of that for sugar-cane juice. In the latter case, only the scums and settlings are filtered, while in the former, the whole carbonated juice is passed through the press.

ESTIMATE OF COSTS AND RETURNS

Cost of fuel.—For the generation of steam for power, juice evaporation, and other purposes, firewood will have to be used. Firewood per ton sap was figured as follows:

	Kilograms of steam per ton of juice.
Power and evaporating	411.2
Evaporating of extra water added in heating, and sundry	34.1
Loss by radiation	2.5
Drying in granulators	1
Unforeseen	2
Total	450.8

Allowing 5 kilograms steam per kilogram of firewood of 10,000 British thermal units the firewood consumption for the evaporation of one ton of sap will be 90 kilograms.

[3] Cane Sugar, new ed. 285.

The firewood to be used in the lime kilns may be estimated at 57 kilograms per ton of juice. Adding this amount to that required in the evaporation of the sap a total of 147 kilograms of firewood per ton of juice will be needed.

The cost of firewood (bakawan) delivered at Semawang is 33 centavos per 100 kilograms, so that the cost of fuel per ton of juice would be 48.5 centavos. Sap produces 1.39 piculs per ton, and cost of firewood per picul would be 33 centavos. Any extra power needed may be generated from the alcohol from molasses.

Lime.—Lime was figured, on 5 per cent of the weight of sap, to cost 15 pesos per ton. Using the smearing method, which would require 20 per cent of lime on the weight of sap, the cost of lime per picul of sugar would be 2 pesos. This high cost of lime would be prohibitive and would exclude the use of this method on a commercial scale. With the cup method, using a total of about 5 per cent of lime on weight of sap, the cost of lime per picul of sugar would be 50 centavos.

The estimated cost of 15 pesos a ton for lime may be reduced to a very low figure by the return of the filter-press cake from carbonated juice. Only a small percentage of the raw material need be replaced from time to time, for the amount lost in the field and that which goes into solution in the sap. Mr. Wood gave us the probable cost of raw materials of which there is said to be an almost inexhaustible supply at Kinabatangan River, near Sulcan or Bilit about 100 miles from Semawang. The transportation of the lime to Semawang would cost 2.30 pesos per ton. Including quarrying the cost of the raw material would not be over 4 pesos per ton. The estimate of 11 pesos per ton for the handling in the factory seems to be very conservative.

TABLE 13.—*Analyses of the nipa sugars.*

Sample.	Sodium chloride (NaCl).	Moisture.	Ash.	Polarization.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
A sugar; unwashed sugar, strike 1	0.55	1.17	1.11	95.1
Sundried A sugar; first sugar made with little washing	0.21	0.74	0.24	97.9
Sundried A sugar; washed sugar made from heavily limed juice	0.06	0.45	0.24	99.1
Sundried A sugar; washed sugar made from slightly limed juice	0.07	0.52	0.21	98.9
B sugar	1.34	4.34	3.15	85.6

Cost of bisulphite.—The cost of bisulphite would be 5 centavos per picul of sugar made.

Final molasses.—Estimated gallons of molasses per ton of nipa sugar is 139.7, which is about twice as much as the average per ton from cane.

The total fermentable sugar in the nipa molasses per unit weight will be approximately the same as for cane molasses, so that the only difference to be taken into consideration in comparing the two is in the amount produced per ton of sugar.

A comparison of probable operating expenses for cane- and nipa-sugar manufacture is given in Table 14. The figures for cane sugar were obtained from the published statements of the Philippine National Bank Sugar Centrals Agency.

TABLE 14.—*Comparison of probable operating costs of nipa with those of cane-sugar manufacture.*

	Cane; 1.69 piculs sugar per ton cane.	Nipa; 1.69 piculs sugar per ton sap.	Nipa; 1.39 piculs sugar per ton sap.
Ordinary expenses:	*Pesos.*	*Pesos.*	*Pesos.*
Administration	0.38	0.38	----------
Milling	0.47	----------	----------
Fabrication	0.64	0.64	----------
Transportation	0.97	0.97	----------
General repairs [a]	0.33	0.35	----------
Property department	0.09	0.09	----------
Sugar-sales expenses	0.20	0.20	----------
Ordinary off-season expenses	0.57	0.57	----------
Prorata; Philippine Sugar Centrals Agency	0.17	----------	----------
Unusual expenses:			
Factory	0.07	0.07	----------
Floating equipment	0.04	----------	----------
Tie replacements	0.28	----------	----------
Inventory shortages	0.23	0.23	----------
Total	4.44	3.50	4.25
Additional expenses for nipa:			
Firewood	----------	----------	0.35
Lime	----------	----------	0.50
Bisulphite	----------	----------	0.05
Total	4.44	3.50	5.15

[a] Expenses for handling bone black, bag filters, and granulators are included in general repairs as the cost of repairs in the nipa plant would be much less than in the cane plant, mills being absent in the nipa-sugar house.

	Pesos.
Cost of central's share of nipa sugar	10.30
Estimated New York price of refined sugar per picul at 10 centavos a pound	13.90
Probable net balance	3.64

The returns from molasses are not included in the estimated balance.

Investment.—If depreciation, interest, and dividends are 30 per cent, a possible capitalization for a 1,000-ton house, operating in a season of 100 days will be approximately 1,700,000 pesos.

The nipa season at Semawang may be extended to 180 days, and possibly to 300 days. A longer season will make it possible to operate the plant on one-half of the probable net balance indicated.

Simpson estimated the probable cost of a 1,000-ton house, including quarters for the laborers and personnel, at 1,000,000 pesos.

It may be desirable to start with a 100-ton house. The foregoing estimates may be used, after allowing an increase in the operating expenses, which will be higher in a small sugar house.

A 100-ton house will require about 1,000 men in the field, about 100 men in the factory, and about 400 hectares of nipales.

COMPARISON BETWEEN THE CANE-SUGAR AND THE NIPA-SUGAR MANUFACTURE

The manufacture of sugar from nipa has the following advantages over that from cane:

1. The crop will be sure every year, unaffected by locust, typhoon or unfavorable weather conditions, or fire.
2. It would be perfectly possible to manufacture refined sugar directly from the sap by a simple process.
3. The absence of a mill plant makes the factory simple and easier to operate with less repair expenses than a cane-sugar factory.
4. The sap, which may be kept for days after it is made alkaline, can be easily transported by water.
5. The sugar season may be extended to ten months or at least six months which will enable the manufacturers to operate on a very narrow margin of profit.
6. There is still a possibility of improving the quality ratio of the sap and thus materially lowering production cost per picul.

There are the following disadvantages in nipa-sugar manufacture compared with cane-sugar manufacture:

1. The quality of juice obtained is dependent on the kind and disposition of the labor used.
2. The amount of labor required in the handling of nipa sap would be much greater than in the cane. For the production and harvesting of 30 tons of cane a conservative estimate of 70 man-days would be required. For the handling of 30 tons of nipa,

153 man-days will be required. Of course, less men would be required in a nipa-sugar factory, but the difference would be comparatively small and will hardly affect the large difference in the man-days labor in the field.

3. The necessity of buying firewood or other fuel to run the nipa-sugar factory may prove to be a source of trouble as the neighboring forests become depleted; a system of reforestation must necessarily be adopted, unless coal or crude oil can be used. However, the Conservator of Forest of the State of North Borneo believes that a 25-year supply can be assured for Semawang.
4. The absence of invert sugar in the nipa sap causes the purity of final molasses made from it to be much higher than in cane molasses, thus making the quality ratio of the nipa sap decidedly higher than of cane, under similar conditions.
5. The nipa is not entirely free from enemies. Parasites may affect the productiveness of the stand by attacking the leaves. The fruits find enemies in wild hogs and monkeys. The latter may prove particularly destructive to the stands that are being tapped as they are wont to come around on occasions and pull off the tuquils from their position, throwing their contents away. We have had trouble with them at Semawang. At times as many as 50 per cent of the tuquils in several fields were emptied by monkeys.

SUMMARY AND CONCLUSIONS

1. Sugar can be manufactured from nipa sap with a reasonable margin of profit.

2. The problems of collecting sap should receive careful attention. The smearing method would not be commercially possible except when the price of sugar is high. Methods that would use less lime but which are just as simple and inexpensive, such as the use of tin cups with baffle plates, should be further studied and tried.

3. Collection should be on a share basis in order to induce the collector to take interest in turning in the greatest amount of sap of the best possible quality.

4. The adoption of a fifty-fifty contract similar to the system generally used in the cane industry would be most convenient.

5. A method of manufacture for the direct production of refined sugar from nipa sap is proposed.

6. Estimates of costs and profits are also given.

7. It is recommended that a 100-ton house be tried first in order that both the field and the technical personnel may acquire experience in the handling of nipa juices.

8. It is necessary to promote the study and investigation of certain chemical problems in the nipa-sugar manufacture, mainly in relation to the chemical control of the sap.

9. Under experimental conditions at Semawang, nipa sap of 12.53 per cent sucrose content was obtained. The lowest purity of B molasses given by an A molasses of 69 purity from a slightly limed juice was 57.8. It should be possible to exhaust the molasses to a purity of 50.

10. With a sucrose recovery of 70 per cent, a polarization in sugar of 99.0, and 4 per cent sucrose in mechanical losses, the sap obtained at Semawang gives a quality ratio of 11,323 and 1.39 piculs sugar per ton sap.

11. A table of comparison of operating costs of nipa-and-cane-sugar manufacture is given.

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ILLUSTRATIONS

TEXT FIGURES

DESCRIPTION OF A NEW PHILIPPINE SHARK

By Albert W. Herre

Of Stanford University, California

HEMIGALEUS MACHLANI sp. nov.

Teeth $\frac{2}{4}\frac{1}{0}$; upper teeth larger, oblique, broad-based, with a long sharp point and five or six denticulations on the concave cutting edge; three middle rows small, erect, simple; lower teeth small, acute, slender, smooth, nearly erect, the last seven rows on each side very much reduced; spiracle hardly half an eye diameter behind eye, much larger than pores; head depressed anteriorly, much wider than high, a trifle less than one-fourth the length; length of snout more than 1.8 times width of arched mouth; length of mouth 1.6 times its own width; labial folds on both jaws at the angle of the mouth, the upper about half the length of the mouth; the lower fold a trifle more than half the length of the upper; eye equal to width of gill openings; nostrils nearer end of snout than angles of mouth, with a triangular lobe over the inner one; pectoral falciform, pointed, a little more than twice as long as broad, extending below middle of dorsal; caudal less than distance between dorsals, nearly 3.6 times in length; the subcaudal lobe pointed; origin of anal behind that of second dorsal, which is larger than anal and two-thirds as large as first dorsal.

Color uniform gray, becoming yellowish white underneath; fins with a reddish or violaceous tinge, more or less pale-edged, the tip of both dorsals whitish.

Type.—No. 11429, Bureau of Science collection; a fine specimen, 773 millimeters long without the caudal, collected by A. W. Herre at Jolo, Sulu Province, Philippine Islands.

I take pleasure in naming this well-differentiated species after my esteemed friend Mr. Perry L. Machlan, of Sitankai, who has been of great assistance to me in my study of the fishes of the Sulu Archipelago.

BAKER'S ENTOMOLOGICA MALAYANA

THE BRACONID GENERA FORMOSIA BRULÉ AND OBLONGOBOLUS ENDERLEIN

By E. A. Cameron

Of the Bureau of Entomology, United States Department of Agriculture

In 1846 Brulé[1] published his genus *Formosia*, based on a single female of undetermined sex from Brazil. He assigned the genus to the group Cryptogasters, which corresponds approximately to the subfamilies Sigalphinae (= Chelonini of Auct.) and Trianpsis (= Sigalphinae of Auct.).

Enderlein's *Oblongobolus*[2] was described without any reason on the part of its author as to its natural position. It was based on two specimens from Formosa.

Ashmead[3] described his *Formosia mansuyeti* from a single male specimen from Manila, Philippine Islands, referring the genus to the Sigalphinae. This specimen is in the United States National Museum. It is certainly an *Oblongobolus*.

Szépligeti[4] in recording *Formosia dubitata* Brulé from Java, placed the genus in the Trianpsis. As pointed out by Enderlein, this is probably a misdetermination.

Cameron[5] records *Formosia dubitata* Brulé as a parasite of *Nilaparvata bimaculata*, and refers it to the Trianpsis.

Beebe[6] records *Formosia dubitata* Brulé as a rather rare parasite emerging from half-grown larvae of *Nilaparvata fuscipennis* in the coast lands of British Guiana. He places it in the Chelonini.

The placing of this group in the Sigalphinae and Trianpsis is one of the many illustrations of the overrating of too much importance to purely adaptive or anomalous characters and the overlooking of the less conspicuous but really significant char-

[1] Hist. Nat. Ins. Hym. 4: 511, pl. 44, fig. 3.
[2] Ent. Mitt. 1 (1912) 266.
[3] Can. Ent. 37 (1905) 7.
[4] Notes Leyden Mus. 29 (1908) 226.
[5] Journ. Roy. Agr. & Comm. Soc. Brit. Guiana 1 (1911) 319.
[6] Trans. Ent. Soc. London 1917 (1918) 216.

acters. The fusion of the basal tergites into a carapacelike structure beneath which the other tergites are hidden occurs in many groups of Hymenoptera, the enumeration of which is unnecessary here.

I have not seen a specimen of *Fornicia clathrata,* so all of my remarks are based on *Odontofornica,* but Brullé's description and figure render it certain that the two are closely allied if not actually congeneric.

Except for the peculiar structure of the abdomen, all of the more important characters ally this group with the Microgasterinæ, where it is most closely related to the genus *Apanteles.* It resembles the last-mentioned genus in general conformation of the head; the medially impressed postvertex and upper occiput with the resulting interruption of the occipital carina; the hairy eyes; the apically truncate clypeus with exposed labrum; the 18-jointed antennæ with the flagellar joints constricted in the middle; the general conformation and structure of the thorax, which, however, provides most of the characters by which the genera are separable; the large hind coxæ, stout femora, compressed hind tibia and tarsus, and ventrally carinate basitarsus; and the venation of the wings. Especially striking in the similarity in the venation is the flexion of subcostella toward mediella and the obsoletely indicated interradiella and closed first cubitellan cell.

From *Apanteles* the genus *Odontofornica* differs principally as follows: Head very small, little more than half as broad as the thorax; mesoscutum with a more or less distinct median carina; scutellum elevated at apex and with an apical toothlike projection which is sometimes bifid; propodeum with the five basal areas distinctly defined; first three tergites fused into a broad, strongly arched, coarsely rugose "carapace," beneath which the remaining tergites are hidden.

Twelve specimens of *Odontofornica* in the United States National Museum, seven from the collection of the late C. F. Baker, represent apparently six species, separable as follows:

Key to the species of Odontofornica Enderlein.

1. Scutellum bidentate at apex; postscutellum medially elevated into a more or less spinelike process ..... 2.
   Scutellum unidentate at apex; postscutellum not especially elevated.. 4.
2. Mesoscutum finely punctate throughout, the median carina weak.... 3.
   Mesoscutum coarsely, rugosely punctate in positions of notauli and around margins, elsewhere sparsely punctate and shagreened, the median carina strong ..... *tagalog* sp. nov.

3. Temples seen from above and cheeks from in front slightly convex. *arata* Enderlein.
   Temples from above and cheeks from in front perfectly straight. *penang* sp. nov.
4. Pronotum medially impressed and triangularly produced on each side of middle ..... 5.
   Pronotum not as above..... *borneanus* sp. nov.
5. Mesoscutum flattened medially but not distinctly impressed, the median carina very strong but not much higher than thick. *annulipes* (Ashmead).
   Mesoscutum longitudinally impressed on each side of the median carina, which is much higher than thick..... *moronis* sp. nov.

ODONTOFORNICA ARATA Enderlein.

Odontofornica arata ENDERLEIN, Ent. Mitteil. 1 (1912) 261.

Before me are two males, one each from Kankau (Koshun), Formosa (H. Sauter) and Yeung Kong, China (C. W. Howard), which differ practically only in color of legs, the Formosan specimen having them largely red. In his description of the species Enderlein mentions this color variation.

The wings in the male are very faintly infumate apically. Face finely, densely punctate, opaque; vertex on each side of median polished depression transversely striate; temples and cheeks rugulose punctate, weakly convex; pronotum flattened and opaquely punctate medially, not triangularly produced on each side of middle; mesoscutum densely finely punctate, opaque, positions of notauli and prescutellar area somewhat but not conspicuously more coarsely and densely punctate, median carina weak; scutellum apically bidentate; postscutellum dentate; mesopleurum, except speculum, and mesosternum finely densely punctate, opaque; abdomen very broad, its breadth little less than combined length of first two tergites, the longitudinal rugæ very strong and distinct, second tergite with about twelve on each side of middle; ovipositor (according to Enderlein) concealed.

ODONTOFORNICA PENANG sp. nov.

Male.—Differs from *O. arata* practically only in its somewhat thinner head with temples and cheeks flat, the antennæ, wing venation, and legs paler, with fully the apical third of the hind tibia red. The wings are not at all infumate. These apparent color differences may be due to immaturity, and more specimens may show that the head differences are mere variation.

Type locality.—Penang Island.

Type.—Catalogue No. 41547, United States National Museum. One specimen from the C. F. Baker collection.

ODONTOFORNICA TAGALOG sp. nov.

Female.—Differs from *O. arata* as follows:

Face shining and more coarsely punctate; temples seen from above slightly concave; mesoscutum opaque shagreened, rugulose punctate around margins and in positions of notauli, elsewhere unevenly and finely punctate, median carina strong but not distinctly elevated; mesopleurum rather coarsely rugulose-punctate, sternum finely and densely punctate; abdomen narrower, its breadth considerably less than combined length of first two tergites; longitudinal rugæ weaker and more or less confused; ovipositor fully as long as abdomen and, if in normal position, would apparently extend a short distance beyond tip of abdomen.

Black; maxillary palpi pale beyond second joint; flagellum brownish basally; wings deeply brownish infumate in apical third, venation dark; legs black, front and middle tibiæ and hind tarsi and apical half of front femur red; basal third of hind tibia white, its apex reddish; all calcaria white; hypopygium black.

Type locality.—Los Baños, Luzon, Philippine Islands.

Type.—Catalogue No. 41548, United States National Museum.

One specimen from the C. F. Baker collection.

ODONTOFORNICA BORNEANUS sp. nov.

This and the following two species differ from the foregoing three species in that the scutellum has a single broad apical tooth instead of two small teeth, and in that the postscutellum lacks the tooth found in the other species.

Female.—Face shining, distinctly but finely punctate; vertex and temples polished, very obscurely punctate, cheeks more distinctly and densely punctate, vertex medially impressed and highly polished, temples from above straight, cheeks from in front convex; pronotum medially flattened and punctate, not triangularly produced on each side of middle; mesoscutum rugulose-punctate around margins and in positions of notauli, elsewhere subpolished and sparsely and weakly punctate, median carina strong; scutellum apically unidentate, postscutellum edentate; mesopleurum coarsely rugulose-punctate, sternum polished and sparsely and finely punctate; abdomen broadly ovate, its breadth nearly as great as combined length of first two tergites, the longitudinal rugæ less strong and more confused than in *O. arata*, second tergite with about twelve on each side of middle; ovipositor barely half as long as abdomen.

Black; maxillary and labial palpi pale, basal joint black; wings faintly infumate apically; hypopygium pale brown; color of legs as in *O. tagalog*.

Type locality.—Sandakan, Borneo.

Type.—Catalogue No. 41549, United States National Museum. One female from the C. F. Baker collection.

ODONTOFORNICA ANNULIPES (Ashmead) comb. nov.

Fornicia annulipes ASHMEAD, Can. Ent. 37 (1905) 7.

In addition to the unique type male there are in the United States National Museum one of each sex labelled "Philippine Islands, C. R. Jones, collector," and one female from northwestern Panay and a male from Los Baños, Luzon, both of the latter from the Baker collection.

Female.—Agrees with *O. borneanus* Cushman in the apically unidentate scutellum and edentate postscutellum, but differs from the above description of that species as follows: Temples convex; pronotum medially impressed and punctate, briefly triangularly produced each side of middle; mesoscutum medially and between notauli and marginal sculpture more shining weakly shagreened, sculpture of notauli and around margins coarser, median carina very strong, about as high as thick; mesopleurum coarsely rugose-punctate above, the sculpture becoming gradually weaker toward the polished and finely punctate sternum; abdomen distinctly narrower, the longitudinal rugæ weaker and much confused; middle tibia blackish in the middle.

Male.—Like female.

ODONTOFORNICA MORONIS sp. nov.

Female.—Similar to *O. annulipes* (Ashmead) in the medially impressed and triangularly produced pronotum, unidentate scutellum, and edentate postscutellum; but the protuberant angles of the pronotum longer; mesoscutum less shining and deeply impressed on each side of the median carina, which is much higher than thick; ovipositor nearly as long as the abdomen; hypopygium blackish; middle tibia entirely red.

Male.—Essentially like female.

Type locality.—Dapitan, Mindanao, Philippine Islands.

Type.—Catalogue No. 41551, United States National Museum. One of each sex from the C. F. Baker collection.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM THE PHILIPPINES (DIPTERA), V [1]

By Charles P. Alexander

Of Amherst, Massachusetts

ONE PLATE

The present report on the crane flies of the Philippines is based on large and important collections that were made by Messrs. R. C. McGregor, Francisco Rivera, and A. C. Duyag, chiefly near Majayjay, on Mount Banahao, Luzon, and by the two latter collectors in Romblon Province. I wish to express my deepest thanks to these gentlemen for their continued interest in making known the very rich tipulid fauna of the Philippines, and for their kindness in allowing me to retain the types of the species herein defined as new.

A critical study of the so-called genera and subgenera that center about *Limonia* Meigen has been made in recent years, and it has become more and more evident that the groups constituting the subtribe Limoniaria are so plastic and grade so insensibly into one another that it is best to recognize the single genus *Limonia*. In this report I wish to discuss the limits of this large and involved genus; to list the characters available for the definition of each of the nineteen included subgenera, as here recognized; to give a key for the separation of these subgenera; and to replace with new names certain of the names that have been invalidated by this consolidation.

THE GENUS LIMONIA MEIGEN

The genus *Limonia* was proposed by Meigen in 1803. Since that date, aberrant and apparently isolated types of crane flies have been added in the vicinity of *Limonia*, most of these having been based primarily on the conformation of the wings and their venation, but a few more especially on the structure of the antennæ and mouth parts. In their typical forms, these various groups have long appeared to be quite valid, but as the fauna of

[1] Contribution from the Department of Entomology, Massachusetts Agricultural College.

the World has become better known it has been found that all of them, in some region or another, pass insensibly toward and overlap others, and, in almost all cases, revert to the typical form of *Limonia*. It has become increasingly difficult correctly to assign these various nontypical forms, and the only course that remains seems to be to consider the various members of the Limoniaria as subgenera under *Limonia*. By such a procedure, any species that are in question will be correctly placed as to genus and any error in the assignment will affect the subgenus only.

The tendencies in the genus *Limonia* in the broadest sense are as follows: Antennæ 14-segmented, very rarely elongated (and then only in the male sex), sometimes pectinate (*Rhipidia* and some species of *Zelandoglochina*). Mouth parts short, with 4-segmented maxillary palpi; greatly elongated in some *Geranomyia* and *Zelandoglochina;* maxillary palpi tending to reduce in number and size of segments. A complete holopticism in a few species. Claws usually pectinate, or at least with a single basal tooth. No tibial spurs. Wings with Sc and R varying in length and relative position in different subgenera and species. The position of the free tip of Sc_2 and its outward shifting has been discussed in detail.[2] Cell M_1 always lacking; condition of cell 2d M_2 and M_3 varying in different subgenera and species; m-cu varying greatly in its relative position to the fork of M; Cu_2 sometimes entirely lacking; vein 2d A present, except in *Doaneomyia*.

The following names are regarded as synonyms: *Aporosa* Macquart, 1838, equals *Geranomyia; Ataracta* Loew, 1850, equals *Limonia; Atypophthalmus* Brunetti, 1911, equals *Limonia; Ceratostephanus* Brunetti, equals *Rhipidia; Glochina* Meigen, 1830, equals *Dicranomyia; Limnobia* Meigen, 1818, equals *Limonia; Limnobiorrhynchus* Westwood, male, 1835, equals *Geranomyia; Limnomyza* Rondani, 1856, equals *Limonia; Plettusa* Philippi, 1865, equals *Geranomyia; Siagona* Meigen, 1830, equals *Dicranomyia*. In addition, the following names, proposed as subgenera, are dropped, as being of less than subgeneric value: In *Geranomyia* (*Triphana* Skuse, *Tetraphana* Skuse, *Monophana* Edwards, *Pseudaporosa* Alexander); in *Rhipidia* (*Monorhipidia* Alexander, *Arhipidia* Alexander, *Conorhipidia* Alexander). The

[2] Alexander, Proc. Linn. Soc. New South Wales 52 (1927) 64–68, figs. 69–78.

The subgenera of *Limonia* are as follows:

Subgenus.	Date.	Genotype.	Region of typical form.
Limonia Meigen	1803	*tripunctata* Fabricius	Holarctic, Ethiopian.
Rhipidia Meigen	1818	*maculata* Meigen	Cosmopolitan, except Ethiopian.
Dicranomyia Stephens	1829	*modesta* Meigen	Cosmopolitan.
Geranomyia Haliday	1833	*unicolor* Haliday	Cosmopolitan, except New Zealand.
Discobola Osten Sacken	1865	*argus* Say	Holarctic, Australasian.
Peripheroptera Schiner	1866	*nitens* Schiner	Neotropical.
Libnotes Westwood	1876	*thwaitesiana* Westwood	Oriental, Australasian.
Dapanoptera Westwood	1881	*perdecora* Walker	Australasian.
Thrypticomyia Skuse	1889	*aureipennis* Skuse	Australasian, Oriental, Ethiopian.
Goniodineura van der Wulp	1895	*nigriceps* van der Wulp	Oriental.
Zalusa Enderlein	1906	*falklandica* Enderlein	Neotropical.
Doaneomyia Alexander	1921	*tahitiensis* Alexander	Australasian.
Euglochina Alexander	1921	*cuneiformis* de Meijere	Oriental Ethiopian.
Idioglochina Alexander	1921	*tusitala* Alexander	Australasian, Oriental.
Pseudoglochina Alexander	1921	*pulchripes* Alexander	Do.
Alexandriaria Garrett	1922	*suffusca* Garrett	Nearctic, Oriental, Australasian.
Zelandoglochina Alexander	1924	*huttoni* Edwards	Neotropical, New Zealand or Maorian.
Laosa Edwards	1926	*gloriosa* Edwards	Oriental.
Neolimnobia Alexander	1927	*diva* Schiner	Neotropical.

above names may perhaps be retained to indicate well-marked groups within their respective subgenera.

The following characters and tendencies of the various subgenera may be indicated:

Limonia MEIGEN, Illiger's Magaz. 2 (1803) 262.

Wings of normal form. Sc long, extending to beyond the origin of Rs but not beyond the end of this vein; free tip of Sc_2 opposite or beyond R_2; m-cu at or before the fork of M, rarely beyond; Cu_2 present.

Rhipidia MEIGEN, Syst. Beschr. 1 (1818) 153.

Essentially a weak modification of *Limonia*, based on the pectinate condition of the antennæ in the male sex. The group grades insensibly into *Limonia* and *Dicranomyia*.

Dicranomyia STEPHENS, Cat. Brit. Insects 2 (1829) 243.

Wings of normal form. Sc short, Sc_1 ending opposite or before the origin of Rs; free tip of Sc_2 usually opposite R_2; m-cu at or before the fork of M; Cu_2 present. Grades perfectly into *Limonia*.

Geranomyia HALIDAY, Ent. Mag. 1 (1833) 154.

Essentially a modification of *Limonia*, based on the produced mouth parts, and especially the very long labial palpi, of both sexes. A reduction in the number of segments of the maxillary palpi from four to one, this being paralleled in other subgeneric divisions. Venation and wing form as in *Limonia* and *Dicranomyia*. The group grades perfectly into *Limonia* and *Dicranomyia*, through *Pseudaporosa* and others, especially in the Australasian and Neotropical Regions.

Discobola OSTEN SACKEN, Proc. Ent. Soc. Philadelphia 1 (1865) 226.

Essentially a *Limonia* with a supernumerary crossvein in cell 1st A.

Peripheroptera SCHINER, Verh. Zool.-bot. Ges. Wien 16 (1866) 933.

Essentially a *Dicranomyia*, characterized by the unusual development of the prearcular cells of the wing, especially in the male. Wings cuneiformly narrowed at base, the apex obtusely rounded; vein Cu_2 partly atrophied, persistent basally, usually becoming obsolete opposite or before midlength of the basal section of Cu_1. Grades perfectly into *Dicranomyia*, especially in the female sex.

Libnotes WESTWOOD, Trans. Ent. Soc. London (1876) 505.

Essentially a *Limonia*, in its typical form characterized by a short, oblique Rs, long Sc, a peculiar caudad deflection of the tips of veins R_3 to M_4, and the great elongation of cell 2d M_2. Wing of typical form, long and very narrow. Very numerous species have been discovered that grade perfectly into *Limonia*. The most satisfactory characters still remaining for separating these two groups are those outlined by Edwards (1928); namely, long Sc, Sc_1 usually ending beyond the fork of Rs; usually oblique Rs; position of m-cu beneath cell 1st M_2, sometimes as far distad as its outer end, in rare cases at the fork of M. The group grades insensibly into *Limonia*.

Dapanoptera WESTWOOD, Trans. Ent. Soc. London (1881) 365.

Essentially a *Limonia*, distinguished by a supernumerary crossvein in cell R_5.

Thrypticomyia SKUSE, Proc. Linn. Soc. New South Wales, II 4 (1889) 774.

A modification of the type of *Dicranomyia*. Wings strongly cuneiformly narrowed; Sc short; free tip of Sc_2 before R_2; R_{1+2} with a strong terminal spur; fork of Rs at near three-fourths the wing length; Cu_2 entirely atrophied; vein 2d A present.

Goniodineura VAN DER WULP, Tijdschr. v. Ent. 38 (1895) 37.

A weak modification of *Libnotes,* represented by a single widespread Malayan species, characterized especially by the strong subbasal angulation of both Rs and R_{2+3}.

Zalusa ENDERLEIN, Zool. Anzeig. 29 (1906) 70–71.

A degenerate modification of *Limonia,* characterized essentially by the subapterous condition of both sexes.

Doaneomyia ALEXANDER, Bull. Brooklyn Ent. Soc. 16 (1921) 11.

Characterized by the total loss of vein 2d A. Wings long-petiolate basally.

Euglochina ALEXANDER, Can. Ent. 53 (1921) 207–208.

A modification of *Dicranomyia,* characterized by the extreme distal position of the cord which lies at or beyond four-fifths of the length of the wing. Wings cuneiformly narrowed; Sc unusually short, ending approximately opposite the tip of vein 2d A; Rs short to very short; Cu_2 atrophied wholly or in part, in the latter case ending before midlength of the basal section of Cu_1.

Idioglochina ALEXANDER, Can. Ent. 53 (1921) 207.

A weak modification of *Dicranomyia,* distinguished especially by peculiar modifications of the antennæ of the male sex, the ventral face of the flagellar segments being greatly produced and provided on the periphery with stout spinous setæ. Some species have been confused with *Rhipidia,* but the nature of the antennal modification is quite distinct in the two groups. The male sex shows a notable incrassation of costa and peculiar arcuations of certain of the veins of the radial field.

Pseudoglochina ALEXANDER, Can. Ent. 53 (1921) 208.

A modification of *Limonia.* Wings strongly narrowed and petiolate at base; elements of anterior cord in oblique alignment, like *Libnotes;* Sc_1 extending some distance beyond base of Rs; cell M_2 open by the atrophy of the basal section of M_3; m-cu at or close to the fork of M; Cu_2 persistent almost to the level of m-cu. Edwards[3] has shown the affinities of this group to *Doaneomyia* and indicated the probable manner in which the second anal vein of the latter group has been lost. It should be further noted that *Doaneomyia* has lost vein Cu_2, whereas *Pseudoglochina* has it long and persistent.

[3] Insects of Samoa, Nematocera (1928) 78–79.

Alexandriaria GARRETT, Proc. Ent. Soc. Washington 24 (1922) 60.

A weak modification of *Dicranomyia*. The essential features of the venation lie in the total loss of cell M_3 by the complete atrophy of m and both sections of M_3. As has been pointed out by Edwards, this is essentially a group of convenience, since the same tendency has been found in several groups of the genus. It is of interest to note that a *Euglochina*, described as new at this time, has this same peculiar venation.

Zelandoglochina ALEXANDER, Ann. and Mag. Nat. Hist. IX 13 (1924) 449–500.

Essentially a *Geranomyia* but with the frontal prolongation of the head short, the maxillary palpi at its apex and thus appearing to lie close to base of rostum. The great elongation of the latter is made up of labial palpi. Antennæ of male strongly nodulose, in one species flabellate as in *Rhipidia*. In the Maorian and Chilian subregions, the group grades insensibly into *Dicranomyia* by a reduction of the mouth parts.

Laosa EDWARDS, Encylop. Entomol. ser. B., Diptera 3 (1926) 48.

A modification of *Limonia*, distinguished especially by the reduction in length to total obliteration of r-m by the approximation of the adjoining veins, together with the presence of supernumerary crossveins in cells R_3 and R_5. Too much importance should not be placed on the latter character, since it is likewise found in certain species of *Libnotes* (as *regalis* Edwards) for which no generic or subgeneric group is deemed necessary.

Neolimnobia ALEXANDER, Proc. Linn. Soc. New South Wales 52 (1927) 68.

Essentially a *Dicranomyia* with a supernumerary crossvein in cell R_3.

A key to the subgenera of the genus Limonia Meigen.

1. A single anal vein present..... *Doaneomyia* Alexander.
   Two anal veins present..... 2.
2. Both sections of vein M_3 and m lacking, cell M_3 thus always lacking.. 3.
   At least the distal section of vein M_3 present and usually both sections, together with m, cell M_3 thus usually present..... 4.
3. Cord of wing lying far distad, at or beyond four-fifths the wing length. *Euglochina* Alexander, in part (*projecta*, sp. nov.).
   Cord of wings normal, not lying beyond two-thirds to three-fourths the length of the wing..... *Alexandriaria* Garrett.
4. Wings reduced to mere stubs in both sexes..... *Zalusa* Enderlein.
   Wings fully developed in both sexes..... 5.

5. Supernumerary crossveins present in one or more cells of the wing.. 6.
   No supernumerary crossveins in cells of wing (except a weak element sometimes evident in subcostal cell) ..... 11.
6. A supernumerary crossvein in cell 1st A..... *Discobola* Osten Sacken.
   No crossvein in cell 1st A..... 7.
7. Supernumerary crossveins in a single radial cell..... 8.
   Supernumerary crossveins in two radial cells..... 10.
8. A supernumerary crossvein in cell R_3..... 9.
   A supernumerary crossvein in cell R_5 ..... *Dapanoptera* Westwood.
9. Sc short, Sc_1 ending opposite or before the origin of Rs; supernumerary crossvein lying distad of the tip of vein R or outer end of cell 1st M_2; m-cu at fork of M..... *Neolimnobia* Alexander.
   Sc long, Sc_1 ending beyond the fork of Rs; supernumerary crossvein lying proximad of R_2 and outer end of cell 1st M_2; m-cu beyond fork of M..... *Libnotes* Westwood. in part (*fuscinervis* Brunetti, *transversalis* de Meijere).
10. r-m greatly reduced or entirely obliterated by the fusion of Rs on M_{1+2}..... *Laosa* Edwards.
    r-m of normal length.... *Libnotes* Westwood, in part (*regalis* Edwards).
11. Mouth parts, and especially the labial palpi, lengthened, longer than the head, usually much longer..... 12.
    Mouth parts, with the labial palpi, not notably lengthened, shorter than the head ..... 13.
12. Antennæ strongly nodulose, rarely flabellate; frontal prolongation of head short, the maxillary palpi not far from base of rostrum. *Zelandoglochina* Alexander.
    Antennæ not nodulose; frontal prolongation long, forming a considerable portion of the base of rostrum, the maxillary palpi at its tip and thus appearing remote from base of rostrum. *Geranomyia* Haliday.
13. Antennæ of male more or less branched (bipectinate, unipectinate, or subpectinate) or with the lower face of the flagellar segments produced to give the organ a serrate appearance..... 14.
    Antennæ simple in both sexes..... 15.
14. Antennæ more or less distinctly branched; bipectinate (*Rhipidia*, s. s.), unipectinate (*Monorhipidia*), or subpectinate (*Archipidia*). *Rhipidia* Meigen.
    Antennæ with the ventral face of each flagellar segment produced into a flattened lobe, its periphery set with stout spinous setæ. *Idioglochina* Alexander.
15. Cord of wings lying far distad, at or beyond four-fifths the length of the wing ..... *Euglochina* Alexander.
    Cord of wings normal in position, lying more proximad, at or near two-thirds and not exceeding three-fourths the length of wing.... 16.
16. Cu_2 entirely lacking..... *Thrypticomyia* Skuse.
    Cu_2 present, in most cases extending to opposite m-cu, at least extending to midlength of the basal section of Cu_1 ..... 17.
17. Wings of male with the prearcular region greatly developed; wing tip very obtuse..... *Peripheroptera* Schiner.
    Wings in both sexes with small, normal prearcular cells; wing tip not conspicuously obtuse..... 18.

18. Both Rs and R_{2+3} angularly bent near origin.
Goniodineura van der Wulp.

Rs sometimes angulated but not coincidentally with any angulation of R_{2+3} ..... 19.

19. Sc relatively short, ending opposite or before origin of Rs.
Dicranomyia Stephens.

Sc ending some distance beyond the origin of Rs..... 20.

20. Wings strongly cuneiformly narrowed at base; Rs and anterior cord in oblique alignment; cell M_2 open by atrophy of basal section M_3.
Pseudoglochina Alexander.

Wings not with the above combination of characters; when Rs and anterior cord are in oblique alignment, cell 1st M_2 closed..... 21.

21. Rs short and oblique, Sc extending to beyond its fork; radial veins deflected strongly caudad at outer ends; m-cu beneath cell 1st M_2.
Libnotes Westwood, in part.

Rs longer and more arcuated, Sc not extending to opposite its fork; veins beyond the cord, including the radial veins, not deflected strongly caudad at tips; m-cu at, before, or only slightly beyond the fork of M ..... *Limonia* Meigen.

As a result of the uniting of the above names in the single genus *Limonia*, a number of specific names become homonyms. A certain number of these are renamed herewith, these including only species described by deceased or inactive workers. A considerable number of additional preoccupied names of species described by contemporary and active workers likewise exist and it is advisable that they be renamed as soon as practicable.

Limonia (*Limonia*) *brunettiella* nom. nov., for *L.* (*L.*) *confinis* Brunetti, Rec. Indian Mus. 15 (1918) 290, nec *L.* (*Dicranomyia*) *confinis* Bergroth, Wien. Ent. Zeitung 8 (1889) 116.

Limonia (*Limonia*) *marginella* nom. nov., for *L.* (*L.*) *marginata* Brunetti, Rec. Indian Mus. 15 (1918) 290, nec *L.* (*Dicranomyia*) *marginata* Macquart, Recueil Soc. Sc. Agr. Lille (1826) 151.

Limonia (*Limonia*) *nigricans* nom. nov., for *L.* (*L.*) *nigrescens* Brunetti, Rec. Indian Mus. 15 (1918) 293, nec *L.* (*Dicranomyia*) *nigrescens* Hutton, Trans. New Zealand Inst. 32 (1900) 34.

Limonia (*Limonia*) *nigrella* nom. nov., for *L.* (*L.*) *nigronitida* Alexander, Ann. Ent. Soc. America 16 (1923) 60–61, nec *L.* (*Geranomyia*) *nigronitida* Alexander, Can. Ent. 53 (1921) 208–209.

Limonia (*Rhipidia*) *willistoniana* nom. nov., for *L.* (*R.*) *costalis* Williston, Trans. Ent. Soc. London (1896) 286, nec *L.* (*Limonia*) *costalis* Wiedemann, Analecta Entomologica (1824) 10.

Limonia (*Rhipidia*) *punctoria* nom. nov., for *L.* (*R.*) *punctipennis* Alexander, Journ. New York Ent. Soc. 22 (1914) 117, nec *L.* (*Dicranomyia*) *punctipennis* Skuse, Proc. Linn. Soc. New South Wales II 4 (1889) 761.

Limonia (*Rhipidia*) *luxuriosa* nom. nov., for *L.* (*R.*) *vicina* Alexander, Trans. Am. Ent. Soc. 42 (1916) 8–9, nec *L.* (*Geranomyia*) *vicina* Macquart, Hist. Nat. d'Îles Canaries, Ent., Dipt. (1838) 101.

Limonia (*Dicranomyia*) *cramptoniana* nom. nov., for *L.* (*D.*) *cramptonia* Alexander, Ent. News 39 (1926) 47–49, nec *L.* (*Rhipidia*) *cramptoni* Alexander, Bull. Brooklyn Ent. Soc. 8 (1912) 10–11.

Limonia (*Dicranomyia*) *divisa* nom. nov., for *L.* (*D.*) *diversa* Osten Sacken, Proc. Acad. Nat. Sci. Philadelphia (1859) 212, nec *L.* (*Geranomyia*) *diversa* Osten Sacken, Ibid. (1859) 207.

Limonia (*Dicranomyia*) *brevivenula* nom. nov., for *L.* (*D.*) *flavescens* Dietz, Trans. Am. Ent. Soc. 47 (1921) 239, nec *L.* (*Limonia*) *flavescens* Macquart, Suit. a Buffon, Dipt. 1 (1834) 103.

Limonia (*Dicranomyia*) *primæva* nom. nov., for *L.* (*D.*) *primitiva* Alexander, Ann. and Mag. Nat. Hist. IX 13 (1924) 562–563, nec *L.* (*D.*) *primitiva* Scudder, Tertiary Insects (1890) 570.

Limonia (*Dicranomyia*) *rostralis* nom. nov., for *L.* (*D.*) *rostrata* Scudder, Tertiary Insects (1890) 571, nec *L.* (*Geranomyia*) *rostrata* Say, Journ. Acad. Nat. Sci. Philadelphia 3 (1823) 22.

Limonia (*Dicranomyia*) *scudderiana* nom. nov., for *L.* (*D.*) *simplex* Scudder, Tertiary Insects (1890) 573, nec *L.* (*Libnotes*) *simplex* Osten Sacken, Ann. Mus. Civ. Genova 16 (1881) 202, and others.

Limonia (*Geranomyia*) *annulosa* nom. nov., for *L.* (*G.*) *annulata* Skuse, Proc. Linn. Soc. New South Wales II 4 (1889) 780, nec *L.* (*Discobola*) *annulata* Linnæus, Syst. Nat. ed. 10 (1758) 586.

Limonia (*Geranomyia*) *skuseana* nom. nov., for *L.* (*G.*) *fusca* Skuse, Proc. Linn. Soc. New South Wales II 4 (1889) 780, nec *L.* (*Dicranomyia*) *fusca* Meigen, Klass 1 (1804) 54, and others.

Limonia (*Geranomyia*) *pallidula* nom. nov., for *L.* (*G.*) *pallida* Williston, Trans. Ent. Soc. London (1896) 284, nec *L.* (*Dicranomyia*) *pallida* Macquart, Dipt. exot. 1 (1838) 72.

Limonia (*Geranomyia*) *austropicta* nom. nov., for *L.* (*G.*) *picta* Skuse, Proc. Linn. Soc. New South Wales II 4 (1889) 778, nec *L.* (*Limonia*) *picta* Heer, Insectenfauna von Oeningen und Radaboj in Croatien 2 (1849) 197.

Limonia (*Geranomyia*) *devota* nom. nov., for *L.* (*G.*) *pulchella* Alexander, Trans. Am. Ent. Soc. 40 (1914) 228–229, nec *L. pulchella* Meigen, Syst. Beschr. 6 (1830) 275.

Limonia (*Geranomyia*) *pictorum* nom. nov., for *L.* (*G.*) *pulchripennis* Brunetti, Fauna British India, Diptera Nematocera (1912) 393, nec *L.* (*Dicranomyia*) *pulchripennis* Brunetti, Ibid. (1912) 376.

Limonia (*Geranomyia*) *tristella* nom. nov., for *L.* (*G.*) *tristis* Loew, Linnaea Entomologica 5 (1851) 398, nec *L.* (*Dicranomyia*) *tristis* Schummel, Beitr. zur Entomol. 1 (1829) 135.

Limonia (*Discobola*) *pictoralis* nom. nov., for *L.* (*Discobola*) *picta* Hutton, Trans. New Zealand Inst. 32 (1900) 37, nec *L.* (*Geranomyia*) *picta* Skuse, Proc. Linn. Soc. New South Wales II 4 (1889) 778.

Limonia (*Discobola*) *venustula* nom. nov., for *L.* (*Discobola*) *venusta* Osten Sacken, Berliner Ent. Zeitschr. 39 (1894) 265, nec *L.* (*Limonia*) *venusta* Bergroth, Wien. Ent. Zeitg. 7 (1888) 193.

Limonia (*Peripheroptera*) *austroandina* nom. nov., for *L.* (*P.*) *subandina* Alexander, Journ. New York Ent. Soc. 27 (1919) 135–136, nec *L.* (*Dicranomyia*) *subandina* Alexander, Proc. U. S. Nat. Mus. 44 (1913) 488.

Limonia (*Libnotes*) *sackenina* nom. nov., for *L.* (*L.*) *simplex* Osten Sacken, Ann. Mus. Civ. Genova 16 (1881) 202, nec *L. simplex* Wiedemann, Aussereur. zweifl. Ins. 1 (1828) 549; nec *L. simplex* Meigen, Syst. Beschr. 6 (1830) 277.

Limonia (*Thrypticomyia*) *unisetosa* nom. nov., for *L.* (*T.*) *arcuata* Alexander, Trans. Am. Ent. Soc. 46 (1920) 4, nec *L.* (*Peripheroptera*) *arcuata* Alexander, Ent. News 24 (1913) 411–412.

TIPULINÆ

PSELLIOPHORA NIGRORUM sp. nov.

Thorax entirely black; anterior vertex abruptly yellow; palpi yellow; fore and middle femora black, the bases narrowly yellow; posterior femora yellow, the tips blackened; all tibiæ black, with a subbasal white ring; wings dark brown, the base broadly yellow; a paler yellow V-shaped area on the disk; abdomen with the basal segments reddish orange, the apex, including the hypopygium, black.

Male.—Length, about 14 millimeters; wing, 14.2.

Frontal prolongation of head very high and tumid, at base fully as deep as the vertex, thus gradually sloping from the vertex to its anterior end, obscure yellow above, dark brown laterally; palpi pale yellow, the distal end of the last segment a little darkened. Antennæ with the scape and basal segment of flagellum yellow; succeeding flagellar segments obscure yellow, the branches black, the apices of the segments narrowly pale; outer flagellar segments uniformly darkened. Head black, the anterior vertex abruptly yellow, the posterior margin of this area evenly rounded.

Prothorax, mesonotum, and pleura entirely deep velvety black. Halteres with the basal half of the stem yellow, the remainder dark brown. Legs with the coxæ black; trochanters reddish yellow; fore and middle femora black, with about the basal

fourth yellow; posterior femora yellow with a little more than the distal third black; all tibiæ black, with a narrow subbasal white ring; tarsi black. Wings dark brown, the base broadly and conspicuously bright yellow, this including the entire prearcular region and bases of the cells beyond, with the basal third of cell 2d A of this color; a conspicuous V-shaped mark on disk that is of a somewhat paler yellow than the base; pale streaks along vein 1st A and near central portion of this cell.

Basal four abdominal segments reddish orange, the remainder, including the hypopygium, black; basal sternites black medially, broadly reddish laterally, the amount of black increasing on the outer segments. Male hypopygium with the lateral lobes of the tergite densely tufted with setæ. Eighth sternite carinate medially, the prow-shaped apex chiefly reddish fulvous.

NEGROS, northern Oriental Negros, Lake Dako, July, 1925; holotype, male.

By Edwards's key to the Philippine species of *Pselliophora,*[4] *P. nigrorum* runs to couplet 7, agreeing with *P. tigriventris* Alexander in the broad yellow wing bases but differing conspicuously in the entirely black thorax and the coloration of the abdomen, which has about the basal half uniformly red, the apex entirely black.

SCAMBONEURA PRIMÆVA sp. nov. Plate 1, figs. 1 and 2.

General coloration obscure fulvous yellow, the præscutum with four shiny plumbeous stripes that are narrowly bordered by black; antennal flagellum black; wings relatively broad, tinged with gray; Rs and the anterior cord in approximate transverse alignment, the latter not arcuated; cells of the medial field of wing relatively wide; abdominal tergites obscure yellow, the subcaudal portions shiny plumbeous, the caudal margins narrowly dark brown.

Female.—Length, about 15 millimeters; wing, 13.

Frontal prolongation of head deep fulvous, with a narrow dorsomedian black vitta that includes the conspicuous nasus; palpi dark brown, the two intermediate segments somewhat paler. Antennæ with the scapal segments obscure yellow; first flagellar segment dark brown; remainder of organ black. Head fulvous yellow, the anterior vertex narrowly lined with black.

Pronotum brown, more yellowish dorsomedially. Mesonotal præscutum obscure fulvous yellow with four shiny plumbeous

[4] Notulae Entomologicae 6 (1926) 41.

stripes that are narrowly margined with black; scutal lobes similarly darkened; scutellum dark, more brownish yellow laterally, the parascutella yellow; postnotum dark brown. Pleura obscure fulvous yellow, the meron darker; posterior sclerites, including the pleurotergite, more testaceous yellow. Halteres brown, the knobs darker, the base of the stem restrictedly pale. Legs with the coxæ reddish brown; trochanters pale brown; femora yellowish brown, brighter basally; tibiæ dark brown, the tips narrowly blackened; tarsi passing into black. Wings (fig. 1) relatively broad, tinged with gray; cell Sc darker; stigma small, pale brown; veins dark brown. Venation: Rs very short, in approximate alignment with the remainder of the anterior cord, the latter not strongly bowed, as in the other known species of the genus; R_2 lost by fusion of R_1 with R_{2+3}; distal section of R_{1+2} atrophied; forks of medial field relatively short and broad; m-cu very erect, its angle with Cu_1 obtuse.

Abdominal tergites obscure yellow, the subcaudal portions of the intermediate segments more plumbeous and highly polished; caudal margins of the segments narrowly dark brown; sternites more uniformly brownish yellow. Ovipositor with the genital shield shiny castaneous; tergal valves of ovipositor yellowish horn color.

LUZON, Mountain Province, Benguet, Pauai (Haight's place), altitude about 2,400 meters, May 1926; holotype, female.

Scamboneura primæva is very distinct from the other Philippine species of the genus. By the author's key to the species of *Scamboneura*,[5] the present form would run to *S. faceta* Alexander, a very different fly. The generalized condition of the venation of the radial field of the wing is noteworthy and finally settles the argument that the small transverse element at the proximal end of the stigma, first interpreted as being Rs, really is this vein. The strongly bowed condition of the anterior cord in the other known species of the genus, with a small spur jutting basad into cell R, lead to the possibility of an alternative interpretation,[6] but the primitive condition of the venation in the present species proves that the original explanation of this remarkable venation is the correct one. The venation of *S. psarophanes* Alexander is shown for comparison (fig. 2).

[5] Philip. Journ. Sci. 33 (1927) 293.

[6] Alexander, Proc. Linn. Soc. New South Wales 52 (1927) 60, fig. 54.

Genus MACGREGOROMYIA novum

Frontal prolongation of head relatively stout, the nasus unusually long and slender. Antennæ apparently only 12-segmented, the basal segment elongate. No vertical tubercle. Legs long and slender; tibial spurs small; claws (♀) simple. Wings (fig. 3) with Sc_1 completely preserved, Sc_2 short, at its tip; Rs strongly arcuated; r-m connecting with Rs at nearly its own length before the fork; R_{2+3} gently arcuated on basal half; free tip of Sc_2 and R_{1+2} entirely preserved, converging outwardly, cell Sc_2 broadest at proximal end; R_3 long, cell R_2 at margin very wide; cell 1st M_2 present; all medial cells relatively deep; m-cu just beyond the fork of M; vein 2d A nearly straight. Ovipositor with the valves chitinized, the tergal valves nearly straight and relatively slender; sternal valves very short and high, nearly as wide as long.

Genotype, *Macgregoromyia benguetensis* sp. nov. (Oriental Region.)

I take great pleasure in naming this new group in honor of my friend and colleague, Mr. Richard C. McGregor, to whom I am very greatly indebted for aid in a study of the rich crane-fly fauna of the Philippines and for other kind favors. I cannot refer the present fly to any of the described groups of tipuline crane flies. The position of r-m on Rs before the fork of the latter provides a unique character for the definition of the present group. Other striking characters and combinations of characters lie in the retention of Sc_1, the preservation of R_{1+2} and its close approximation at wing margin to the free tip of Sc_2, the long, parallel-sided cell 1st M_2, and the position of m-cu.

MACGREGOROMYIA BENGUETENSIS sp. nov. Plate 1, fig. 3.

General coloration fulvous brown, the mesonotum chiefly dark brown; base of antennæ yellow, the outer segments dark brown; pleura pale, variegated with dark brown; legs relatively long and slender; femora obscure yellow at base, more darkened outwardly, the tips again paler; wings pale yellow, longitudinally striped with brown; abdominal tergites dark brown, the caudal margins of the segments broadly brownish yellow.

Female.—Length, about 14 millimeters; wing, 13.8.

Frontal prolongation of head brownish yellow, darker laterally; nasus long, slightly widened distally, a little brighter than the front; palpi pale brown, the third segment brighter, the

terminal segment broken. Antennæ with the first segment yellow, the second segment almost white; basal two flagellar segments yellow, the succeeding segments passing into brown. Head dark fulvous brown; anterior vertex wide.

Pronotum chiefly brownish yellow. Mesonotal præscutum with the disk largely covered by confluent brown stripes, the broad lateral margins abruptly yellow; margins of lateral stripes and anterior interspaces a little darker than the stripes; scutal lobes darkened, the median area slightly paler; scutellum dark brown; postnotum dark brown, laterally with dense yellow pollen. Pleura pale, the anepisternum and sternopleurite variegated with dark brown. Halteres relatively long and slender, pale, the base of the knobs dark brown, the apex paler. Legs with the coxæ dark brown; trochanters obscure yellow; femora obscure yellow, darkened outwardly, the tips paling into yellow; bases of tibiæ narrowly yellowish, the remainder of the legs passing into dark brown. Wings (fig. 3) with the ground color pale yellow, the veins conspicuously bordered with brown to produce a vittate appearance; cell C brownish yellow, pale yellow at outer end; cell Sc more uniformly yellow; cord conspicuously seamed with brown; radial cells more uniformly infumed, the proximal two-fifths of cell R_3 pale yellow; cells beyond cord infumed, a large area centering about cell 1st M_2, together with all of cell M_1 pale; bases of cells R and M, basal two-thirds of Cu, vein 2d A and axilla all conspicuously variegated with brown. Venation as discussed under the generic diagnosis.

Abdominal tergites dark brown, the caudal margins of the segments broadly brownish yellow; sternites more uniformly brownish yellow. Ovipositor with the tergal valves brownish horn color.

LUZON, Mountain Province, Benguet, Pauai (Haight's place), altitude about 2,400 meters, May, 1926; holotype, female.

LIMONIINÆ

LIMONIA (LIBNOTES) IGOROTA sp nov. Plate 1, fig. 4.

Size large (wing, ♂, over 20 millimeters); general coloration yellow, the posterior sclerites of the mesonotum variegated with dark brown; antennal flagellum and terminal segments of palpi yellow; thoracic pleura yellow, narrowly lined with dark brown; halteres yellow; legs yellow, the femora only vaguely darkened subapically on outer face; wings with a strong yellow tinge, the veins with long brown streaks, on Cu and on R_{4+5} extending

almost unbroken the entire length of the vein; R_{1+2} about three times R_2 alone; inner end of cell 2d M_2 far proximad of cell M_3.

Male.—Length, about 15 millimeters; wing, 22 by 4.6.

Rostrum dark brown; palpi short, the first segment dark brown, the short outer three segments yellow. Antennæ with the scapal segments dark brown; flagellum abruptly light yellow; basal segments of flagellum with relatively short spinous verticils; outer segments more elongate. Head deep fulvous yellow, without markings; anterior vertex reduced to a strip.

Pronotum yellow. Mesonotal præscutum greenish yellow, with four nearly concolorous stripes, these becoming narrowly dark brown just before the suture; scutum with the median area greenish gray, the lobes olive-yellow with their centers dark brown; scutellum dark brown, the median area obscure yellow; postnotal mediotergite dark brown, the caudal margin narrowly yellow, the disk with a conspicuous median pale area that is narrowed behind. Pleura yellow with two narrow, slightly interrupted, dark brown, longitudinal stripes; dorsal stripe extending from the ventral margin of the pronotum, across the propleura and anepisternum, onto the pteropleurite, interrupted beyond this by the pleurotergite, which has only a small area above the halteres; ventral stripe interrupted, beginning on the fore coxa, including large areas on the sternopleurite and middle coxa, and above the hind coxa. Halteres entirely yellow. Legs with the fore and middle coxæ yellow, the outer face darkened as above described; hind coxæ yellow; trochanters obscure yellow; femora obscure yellow, with a barely indicated subterminal darkening that does not form a complete ring, the tips clear yellow; tibiæ and tarsi obscure yellow, the latter passing into black; segments, especially of the fore legs with the setæ reduced to tiny spines. Wings (fig. 4) with a strong yellow tinge, the veins conspicuously seamed with brown, the seams along Rs, R_5 and Cu nearly uninterrupted; other areas include a streak on R_{2+3} below the fork of Sc, R_2, tip of R_{1+2} a long area at outer end of M_{1+2}, outer end of cell 1st M_2 and the tips of the anal veins; a dark marginal seam from 1st A almost to the tip of vein M_4; veins yellow, darker in the infuscated areas. Venation: Sc_2 at tip of Sc_1; Rs short, oblique; R_{1+2} elongate, fully three times R_2 alone, the free tip of Sc_2 carried to its extreme outer end; proximal end of cell 2d M_2 lying far proximad of cell M_3; m-cu about two and one-half times its length beyond the fork of M.

Abdominal tergites brownish yellow, with a narrow, dark brown lateral stripe that becomes obsolete on the outer segments; hypopygium yellow.

LUZON, Mountain Province, Benguet, Baguio; holotype, male.

In its large size and general coloration of the wings, *L.* (*L.*) *igorota* resembles *L.* (*L.*) *regalis* (Edwards), of Formosa, differing conspicuously in the entire lack of supernumerary crossveins, and all details of coloration of the body, antennæ, and legs. By Edward's key to the species of *Libnotes*,[7] the present species runs to couplet 13, disagreeing with both included groups of species by the combination of striped thoracic pleura and uniformly yellow halteres. The pale yellow antennal flagellum and almost immaculate femora are conspicuous features of the present species.

LIMONIA (LIBNOTES) BANAHAOENSIS sp. nov. Plate 1, fig. 5.

General coloration brownish gray; antennæ black throughout; pleura pale yellow, with a transverse brown girdle; legs brown, the narrow tips of the femora and the bases of the tarsi paler; wings whitish subhyaline, with a heavy brown pattern, including areas in the base of cell R and at the wing tip; costal margin yellow, alternating with larger brown areas; Rs arcuated; free tip of Sc_2 before R_2; cells 2d M_2 and M_3 with their inner ends in transverse alignment.

Sex?.—Wing, 6.7 millimeters.

Rostrum about one-half the length of the head, pale brown basally, the apex and palpi black. Antennæ black throughout; flagellar segments long-oval, the unilaterally arranged verticils approximately twice the segments. Posterior vertex dark, the narrow anterior vertex more grayish. Eyes large, contiguous or virtually so on dorsum.

Mesonotum almost uniformly brownish gray, the præscutum with a median darker brown stripe; scutellum more testaceous; pleurotergite yellow. Pleura pale yellow, with a brown transverse girdle, involving the cephalic portions of the anepisternum and sternopleurite, the posterior margin of the propleura, and the fore coxæ. Halteres elongate, dark brown. Legs with the fore coxæ dark, the remaining coxæ and all trochanters pale yellow; femora brown, the bases paler, the extreme tips narrowly yellow; tibiæ brown, the tips paling into brownish yellow; basal two tarsal segments yellow, the terminal segments black. Wings (fig. 5) whitish subhyaline, with a heavy brown pattern;

[7] Journ. Federated Malay States Mus. 14 (1928) 74–80.

costal margin in cells C and Sc yellow, alternating with extensive brown areas above h, over origin of Rs, tip of Sc and the small stigmal area above the end of R; wing apex in cells R_2 and R_3 broadly infumed; an extensive dark cloud in base of cell R; broad, conspicuous brown seams along Cu, the cord, outer end of cell 1st M_2, R_{2+3} R_3 and the tip of 2d A; veins dark brown, yellow in the costal interspaces. Venation: Sc_1 extending to shortly beyond the level of r-m; Rs gently arcuated, nearly three times the basal section of R_{4+5}; free tip of Sc_2 about its own length before R_2; radial veins long and extending generally parallel to one another to margin; cell 1st M_2 elongate, gently widened distally, the proximal ends of cells 2d M_2 and M_3 in transverse alignment; m-cu about its own length beyond fork of M; vein 2d A strongly converging toward 1st A on basal half, thence diverging strongly to margin.

Abdomen with the basal segments greenish yellow, a little infumed; abdomen broken beyond the third segment.

LUZON, Laguna Province, above Majayjay, Mount Banahao, altitude over 500 meters, June 10, 1928 (*R. C. McGregor*); holotype.

Limonia (*L.*) *banahaoensis* belongs to the group of the subgenus that includes small *Limonia*-like forms, with the transverse veins at outer end of cell 1st M_2 in alignment. By Edwards's key to the species of *Libnotes*,[8] the present species runs to couplet 36, disagreeing with both groups in the small stigma and clouded wing apex. The coloration of the wings readily separates this species from all forms so far described.

LIMONIA (LIBNOTES) RIVERAI sp. nov. Plate 1, fig. 6.

General coloration gray; rostrum, palpi, and antennæ black; femora brownish yellow, the tips narrowly and inconspicuously brownish black; wings grayish subhyaline, the prearcular region more whitish; stigma lacking; free tip of Sc_2 and R_2 in alignment; proximal ends of cells 2d M_2 and M_3 in alignment.

Female.—Length, about 6 to 7 millimeters; wing, 6.5.

Rostrum and palpi black, the former about one-half the length of the remainder of the head. Antennæ black throughout, the flagellar segments oval, somewhat longer outwardly, the terminal segment nearly twice the penultimate. Anterior vertex narrow, silvery white; remainder of head dark gray, the posterior orbits paler.

[8] Loc. cit.

Mesonotum dark brownish gray, the præscutum with three poorly defined darker brown stripes; posterior sclerites of mesonotum clearer gray. Pleura dark grayish brown, the dorsopleural region paler. Halteres with the stem yellow, the outer end and the knobs dark brown. Legs with the coxæ dark, concolorous with the pleura; trochanters obscure yellow; legs relatively long; femora brownish yellow, the tips narrowly brownish black; tibiæ brown, the tips narrowly darkened; tarsi brownish yellow, the terminal segments blackened. Wings (fig. 6) grayish subhyaline; prearcular region pale; cell Sc a little more infumed; stigma lacking; veins dark brown. Venation: Sc_1 ending about opposite midlength of basal section of R_{4+5}, Sc_2 close to its tip; Rs about twice the basal section of R_{4+5}, the basal half more oblique, the distal half more arcuated; free tip of Sc_2 in alignment with R_2; cell 1st M_2 relatively elongate but shorter than the veins issuing from it; inner ends of cells 2d M_2 and M_3 in alignment; m-cu at near three-fifths to two-thirds the lengh of cell 1st M_2; 2d anal vein diverging gently from 1st A, beyond the base gently sinuous, the cell broad.

Abdomen dark brown. Ovipositor with the valves reddish horn color; tergal valves slender.

LUZON, Laguna Province, above Majayjay, Mount Banahao, altitude over 500 meters, May 30, 1928 (*R. C. McGregor and Francisco Rivera*); holotype, female; paratopotype, female. "On small tree trunk in open field, far from water."

I take great pleasure in naming this interesting *Limonia* in honor of the collector of many of the specimens studied in connection with the present report, Mr. Francisco Rivera. *Limonia* (*L.*) *riverai* differs from all similar *Limonia*-like species of the subgenus *Libnotes* in the gray coloration of the thorax and the unmarked wing. By Edwards's key to the species of the subgenus,[9] the present species would run to couplet 55, disagreeing with both sets of characters in the immaculate wings.

LIMONIA (LIBNOTES) DUYAGI sp. nov. Plate 1, fig. 7.

Ground color reddish yellow, the thorax heavily variegated with brownish black, including three præscutal stripes; knobs of halteres light yellow; legs chiefly yellow, the fore femora with a narrow dark brown subterminal ring; wings subhyaline, the costal border and base more darkened; stigma small, subcircular, darker brown; Rs long; cell 2d M_2 a little longer than

[9] Loc. cit.

cell M_3; m-cu at near midlength of cell 1st M_2; anal veins nearly parallel at base.

Female.—Length, about 6.5 millimeters; wing, 6.8.

Rostrum and palpi black. Antennæ with the scape black, the flagellum much paler, light brown; flagellar segments oval, the verticils not conspicuous. Head dark brownish gray with a blackish median line; eyes broadly contiguous on the vertex.

Pronotum narrowly black medially and laterally, paler on either side of the median line; posterior notum obscure yellow. Mesonotal præscutum with the ground color reddish yellow, the three stripes black, very extensive, confluent behind or nearly so; median stripe constricted and diluted with reddish opposite the anterior ends of the lateral stripes; scutal lobes dark brown, the median area yellow; scutellum brownish black, the base obscure yellow; postnotum brown. Pleura obscure yellow, sparsely variegated with brown, the most distinct area on the anepisternum; dorso pleural region more or less darkened. Halteres pale, the base of the stem and the knobs light yellow. Legs with the coxæ and trochanters yellow, the fore coxæ darker; fore femora yellow with a narrow dark brown subterminal ring, this narrower than the yellow apex beyond; remaining femora with the subterminal dark annulus more diffuse, only the outer end clearly delimited; tibiæ yellow, the tips very narrowly and vaguely darkened; tarsi yellow, the outer three segments dark brown. Wings (fig. 7) subhyaline, the prearcular region, cells C and Sc, and a more-diffuse costal border extending to the wing tip brown; stigma subcircular, darker brown; caudal border of wing more vaguely infumed; a narrow brown seam at origin of Rs; bases of cells R, M, Cu, and 1st A a little clouded; veins dark brown. Venation: Sc_1 ending shortly beyond r-m, Sc_2 a short distance from its tip; Rs long, rather strongly arcuated, some five times the basal section of R_{4+5}; free tip of Sc_2 and R_2 in alignment; cell 2d M_2 a little longer than cell M_3; cell 1st M_2 elongate, m-cu at near midlength, a little shorter than the distal section of Cu_1; anal veins nearly parallel at origin, vein 2d A gently sinuous.

Abdominal tergites dark brown, the sternites more bicolored, the bases and apices of the individual segments yellow, the former more broadly so, the intermediate portion dark brown. Ovipositor and genital segment reddish yellow, the base of the sternal valves blackened; tergal valves relatively small and slender, upcurved.

LUZON, Laguna Province, above Majayjay, Mount Banahao, April 24, 1928 (*A. C. Duyag*).

This interesting *Libnotes* is named in honor of the collector, Mr. A. C. Duyag, who has collected many interesting species of Tipulidæ. By Edwards's key to the species of this subgenus,[10] the present species would run to *L.* (*L.*) *megalops* (Edwards), of Borneo. The latter differs in the uniformly ocherous thorax, brown halteres, and details of the wing pattern and venation.

LIMONIA (LIMONIA) IMPERSPICUA sp. nov. Plate 1, fig. 8.

General coloration reddish brown, the præscutum with a darker brown median stripe; legs brownish black, the femoral bases yellow; wings with a brownish suffusion, the costal margin narrowly dark brown; this continued outwardly to beyond the wing tip; male hypopygium with the rostral prolongation of the ventral dististyle very long and slender, the two spines arising from a common tubercle placed at the base of the prolongation.

Male.—Length, about 8 millimeters; wing, 9.2.

Rostrum and palpi black. Antennæ with the scapal segments black, the flagellum broken. Head dark gray, the anterior vertex lighter gray; eyes shrunken but apparently broadly contiguous above.

Mesonotal præscutum dark reddish brown, with a darker brown median stripe; scutum testaceous yellow, each lobe with a large brownish black area; scutellum dark brown, the base medially pale yellow; postnotum brownish black, the cephalic margin narrowly paler. Pleura pale brownish yellow, with a conspicuous brownish black girdle that includes the anepisternum and sternopleurite; propleura less distinctly infuscated; a dark spot on the ventral pleurotergite. Halteres pale, the knobs infuscated. Legs with the coxæ brownish yellow, the fore coxæ brownish black at base; trochanters obscure yellow; femora dark brown, the bases narrowly yellow, the tips very vaguely pale; remainder of legs black; claws elongate, with a single long basal spine. Wings (fig. 8) with a brownish suffusion, cells C and Sc still darker, the color continued as a narrow costal seam to beyond the wing tip; stigma small, oval, darker brown; small vague brown seams at origin of Rs, along the cord, and in the axillary region; veins dark brown. Venation: Sc_1 ending about opposite two-thirds the length of Rs, Sc_2

[10] Loc. cit.

at its tip; Rs nearly straight beyond base, the distal third more arcuated; free tip of Sc_2 in alignment with R_2; cell 1st M_2 about as long as vein M_3 beyond it; a small spur jutting basad into cell 1st M_2 at the bend of M_3; m-cu at fork of M, a little longer than the distal section of Cu_1.

Abdomen dark brown, the caudal margins of the segments slightly paler; hypopygium dark. Male hypopygium with the ninth tergite transverse, the caudal margin evenly rounded, only vaguely emarginate medially. Basistyle with the mesal lobe relatively large and conspicuously setiferous. Ventral dististyle fleshy, the rostral prolongation slender, chitinized, the two spines placed at the base of the prolongation, arising from a common tubercle, gently curved, shorter than the prolongation alone; face of style near prolongation with a long, fleshy lobe that terminates in two long setæ. Dorsal dististyle a slender, angularly bent, chitinized rod that narrows gradually to the slightly decurved acute tip. Gonapophyses extensive, broad-based, narrowed gradually to the more slender apical points.

LUZON, Laguna Province, above Majayjay, Mount Banahao, altitude over 500 meters, June 2, 1928 (*R. C. McGregor*); holotype, male.

The peculiar structure of the male hypopygium is approached by *Limonia* (*Libnotes*) *termitina* (Osten Sacken), another fact in the long chain that has been accumulated to prove the close relationship existing between the various groups of limoniine Tipulidæ.

LIMONIA (EUGLOCHINA) PROJECTA sp. nov. Plate 1, figs. 9 and 9a.

General coloration dark brown; proximal ends of basitarsi blackened; wings elongate, cuneiformly narrowed at base, suffused with brown, especially on the costal and apical portions; Sc_2 ending opposite the end of vein 2d A; cell M_3 lost by the complete atrophy of m and both sections of vein M_3.

Male.—Length, about 6.5 to 8 millimeters; wing, 6 to 7.5.

Female.—Length, about 6 to 6.5 millimeters; wing, 6 to 7.

Rostrum and palpi dark brown. Antennæ with the scapal segments brown, the flagellum somewhat darker; flagellar segments elongate-fusiform, the longest verticils unilaterally arranged. Head black, the anterior vertex broad, more silvery.

Mesonotum dark brown, the pleura more yellowish testaceous. Halteres elongate, pale, the outer end of the stem and the knobs dark brown. Legs with the coxæ and trochanters yellowish

testaceous; femora and tibiæ black; basitarsi black at base, the remainder of tarsi snowy-white. Wings (figs. 9, 9*a*) long and narrow, the basal pedicel unusually long; membrane with a brownish suffusion, the costal region and apex darker brown; stigma long-oval, dark brown; veins black, the obliterative areas extensive. Venation: Sc short, ending opposite or just before the level of the end of vein 2d A, Sc_2 at the extreme tip of Sc_1; cord lying unusually far distad, at or beyond five-sixths of the length of the wing; Rs short, less than the angulated basal section of R_{4+5}; free tip of Sc_2 and R_2 in alignment; cell M_3 lacking by the atrophy of m and both sections of vein M_3; m-cu more than one-half its length beyond the fork of M; Cu_2 lacking.

Abdomen brownish black, including the hypopygium.

TABLAS, Badajoz, August 21, 1928 (*Francisco Rivera and A. C. Duyag*); holotype, male; allotype, female; August 20 to 27, 1928, nine paratopotype males and females. ROMBLON, August 16, 1928 (*Francisco Rivera and A. C. Duyag*), paratype male.

Limonia (*Euglochina*) *projecta* marks the extreme tendency of venation in the subgenus. The cord lies far distad and cell M_3 is entirely lacking by the atrophy of m and both sections of vein M_3, the latter condition being identical with the subgenus *Alexandriaria* Garrett. I have seen another species of *Euglochina* from Sumatra with the same peculiar venation.

HELIUS (HELIUS) ARCUARIUS sp. nov. Plate 1, fig. 10.

General coloration brownish yellow, the pleura clearer yellow; rostrum relatively long and slender; antennæ black throughout; legs brownish black, the tarsi paling into yellowish brown; wings subhyaline, the costal margin narrowly infuscated; R_{2+3} long, strongly arcuated at origin, beyond the base running parallel to R_1 or nearly so, this part of cell R_1 greatly narrowed; cell 1st M_2 long, m-cu near its base.

Male.—Length (excluding rostrum), about 4.5 millimeters; wing, 5.6; rostrum alone, about 0.7.

Rostrum relatively long and slender, approximately twice the remainder of the head, brownish black; palpi black. Antennæ longer than the rostrum, black throughout; flagellar segments long-oval, with an abundant erect pubescence. Head black.

Mesothorax almost uniformly brownish yellow, the dorsum darker medially, the pleura clearer yellow. Halteres dark brown, the base of the stem narrowly pale. Legs long and slender, the coxæ and trochanters obscure yellow; femora and tibiæ brownish black, the femoral bases narrowly paler; tarsi

paling to yellowish brown. Wings (fig. 10) subhyaline, cells C and Sc and the stigmal region infuscated to produce a dark costal border; veins brown. Venation: Sc_2 ending shortly beyond r-m, Sc_1 indistinct; Rs gently arcuated; R_{2+3} long, strongly arcuated at origin, beyond the base lying close to R_1, this part of the cell being narrow and generally parallel-sided; cell R_1 at margin a little more than one-third cell R_3; r-m just beyond the fork of Rs; cell 1st M_2 long-rectangular, shorter than the veins issuing from it; m-cu just beyond the fork of M, near the base of cell 1st M_2.

Abdominal tergites dark brown, the sternite obscure yellow; hypopygium dark. Male hypopygium with a conspicuous setiferous lobe on mesal face of basistyle, much as in most species of *Limonia*. Outer dististyle shorter than the inner, narrowed to the simple obtuse apex. Gonapophyses with the mesal hook very long and conspicuous.

LUZON, Laguna Province, above Majayjay, Mount Banahao, altitude over 500 meters, June 3, 1928 (*R. C. McGregor*); holotype, male.

Helius arcuarius is a very distinct species, in the darkened costal margin of the wing agreeing most closely with *H. fumicosta* Edwards, an otherwise entirely different fly. In the peculiar arcuation of vein R_{2+3}, it agrees with *H. longinervis* Edwards, a member of the subgenus *Eurhamphidia* Alexander, with r-m placed before the fork of Rs. The genus *Helius* includes a wide range of types, some of which well warrant subgeneric separation.

LECHRIA LUZONICA sp. nov. Plate 1. fig. 11.

General coloration shiny chestnut brown, the pleura more yellowish; antennæ black, the first scapal segment yellow; head dark gray; legs brownish black; cell 1st M_2 of moderate length; m-cu about one and one-half times its length beyond the fork of M and some distance before the level of r-m.

Male.—Length, about 5 millimeters; wing, 5.5.

Female.—Length, about 6 millimeters; wing, 7.

Rostrum brownish yellow; palpi brownish black. Antennæ with the first scapal segment yellow, the remainder of the organ black; flagellar segments suboval. Head dark gray; eyes above broadly contiguous.

Mesonotum shiny chestnut brown, the pleura more yellowish. Halteres brown, the base of the stem yellowish. Legs with the coxæ and trochanters yellowish; femora brownish black, the

bases narrowly and vaguely paler; tibiæ and tarsi dark brown. Wings (fig. 11) subhyaline, the costal region more yellowish; veins brownish black, C, Sc, and R paler. Venation: Sc_2 at tip of Sc_1, both lying shortly beyond the fork of Rs; cell 1st M_2 relatively short (as compared with *L. philippinensis*); m-cu about one and one-half times its length beyond the fork of M, at about one-third the lower face of cell 1st M_2; r-m lying distinctly distad of m-cu.

Abdominal tergites dark brown medially, paler brownish yellow laterally; sternites obscure yellow; eighth segment blackened; male hypopygium brownish yellow.

LUZON, Bulacan Province, San Jose del Monte, July 8, 1928 (*R. C. McGregor*); holotype, male; allotype, female; paratypes, three males and females.

Lechria luzonica seems to be most closely allied to *L. philippinensis* Alexander, despite the appearance of cell 1st M_2, which is more like the normal condition in the genus. From *L. lucida* de Meijere and *L. bengalensis* Brunetti, it differs notably in the coloration of the body and legs, as well as in the details of venation. A figure of the venation of *Lechria philippinensis* Alexander (fig. 12) is given for comparison.

Key to the Philippine species of Lechria Skuse.

Wings (fig. 12) with the costal cell brown; cell 1st M_2 very long and narrow, m-cu only a short distance before the level of r-m, fully twice its length beyond the fork of M; abdominal segments obscure yellow, at base narrowly cross-banded with brown.
L. philippinensis Alexander.

Wings (fig. 11) with the costal cell yellowish; cell 1st M_2 of normal size, m-cu some distance before the level of r-m, about one and one-half times its length beyond the fork of M; abdominal tergites obscure yellow with a brown dorsomedian stripe; sternites uniformly yellow ..... *L. luzonica* sp. nov.

ERIOCERA FLAVIDIBASIS sp. nov.

General coloration brownish black, sparsely pruinose; antennal scape black, the flagellum brownish yellow; legs entirely brownish black; wings dark brown, the broad base and a conspicuous discal area yellow; cell M_1 present but tending to be evanescent by atrophy; abdomen brownish black.

Male.—Length, about 11 millimeters; wing, 14.

Rostrum and palpi black. Antennæ short, the scapal segments black, sparsely dusted with gray; flagellum conspicuously brownish yellow, the outermost segments a little darker. Head dull brownish gray.

Mesonotum dark brownish gray, the præscutum with three more glabrous, nearly concolorous stripes. Pleura brownish black, dusted with gray, the pleurotergite transversely ribbed with finer lines. Halteres brownish black. Legs entirely brownish black, all legs relatively stout. Wings strongly suffused with brown; wing base broadly light yellow, the color including all the prearcular region, the basal third of cell C and the narrower bases of cells Sc, 1st A, and 2d A, the former a little deeper in color than the two latter; the discal pale area relatively narrow in cell R_1, slightly wider behind, not crossing Cu, pale yellow in color. Venation: Cell M_1 present, in both wings of the type, vein M_1 represented only by a basal spur, the apex atrophied; m-cu beyond midlength of cell 1st M_2, about twice the distal section of Cu_1.

Abdomen brownish black, subnitidous, the caudal margins of the tergites narrowly paler; hypopygium black, with long conspicuous yellow setæ.

LUZON, Mountain Province, Benguet, Adaoay, April, 1924; holotype, male.

By Edwards's key to the Philippine species of *Eriocera*,[11] *E. flavidibasis* runs to couplet 9. It agrees with *E. griseicollis* Edwards in the retention of cell M_1 and the stout legs, differing in the coloration of the body, antennæ, and wings. From *E. crassipes* Bezzi, the present species differs in the stout fore and middle legs, the general coloration and venation.

ERIOCERA GLABRIVITTATA sp. nov.

General coloration black, the mesonotal præscutum velvety black, the usual three stripes shiny plumbeous black; femora yellow, the tips broadly blackened; wings broad, the base, especially in the anal cells, and a broad discal area whitish; cell M_1 lacking; abdominal tergites subnitidous, blue-black; basal shield of ovipositor brown, densely covered with an appressed golden pubescence.

Female.—Length, about 16 millimeters; wing, 15.

Rostrum and palpi black. Antennæ broken. Head black, sparsely pollinose.

Mesonotal præscutum velvety black, the usual three stripes separate, shiny plumbeous black; centers of the scutal lobes similarly glabrous; scutellum black, sparsely pruinose. Pleura black. Halteres brownish black. Legs with the coxæ and trochanters black; femora yellow, the tips broadly blackened; tibiæ

[11] Notulae Entomologicae 6 (1926) 38–39.

black, on at least one leg (detached) just beyond the base and extending for about one-half the length of the sclerite brownish yellow; tarsi black. Wings broad, suffused with dark brown, the prearcular region extensively brighter, almost whitish, in the costal region passing beyond h; bases of both anal cells broadly whitened, the remainder of these cells grayish; a broad, conspicuous, whitish crossband before the cord, this generally parallel-sided, extending from R to Cu; veins pale brown, more yellowish in the discal pale area. Venation: Cell M_1 lacking; m-cu immediately before midlength of cell 1st M_2.

Abdominal tergites blue-black, subnitidous, without pale markings; sternites more reddish brown. Ovipositor with the dorsal shield brown, densely covered with an appressed golden pubescence; valves elongate, slender, reddish horn color.

LUZON, Mountain Province, Benguet, Pauai (Haight's place), altitude about 2,450 meters, April 1, 1925 (*Francisco Rivera*); holotype, female.

By means of Edwards's key to the Philippine species of *Eriocera*,[12] the present species runs to couplet 3, disagreeing with both included species in the diagnostic characters indicated above.

ERIOCERA CARBONIPES sp. nov.

General coloration of head and thorax dark grayish black, the præscutum with three glabrous plumbeous black stripes that are confluent behind; legs and halteres entirely black, the former relatively slender; wings dark brown, the bases of the anal cells and a conspicuous area before the cord white; cell M_1 lacking; abdomen shiny blue-black, the hypopygium black.

Male.—Length, about 12 millimeters; wing, 12.8.

Rostrum and palpi black. Antennæ with the scape black; flagellum broken. Head dull grayish black.

Mesonotal præscutum dull black, with three shiny plumbeous black stripes that are entirely confluent behind, the humeral inter-spaces being restricted to elongate triangles; posterior sclerites of mesonotum similarly dark leaden gray. Pleura black, sparsely pruinose, especially on the pleurotergite. Halteres black. Legs relatively slender, entirely black. Wings dark brown, the bases of the anal cells broadly whitened; costal cell before h a little pale; a conspicuous white discal area before cord, extending from vein R_1 to Cu_1; veins dark brown. Vena-

[12] Loc. cit.

tion: Cell M_1 lacking; m-cu at midlength of cell 1st M_2, more than twice the distal section of Cu_1.

Abdomen shiny blue-black, the hypopygium black.

LUZON, Mountain Province, Ifugao, Kiangan, altitude about 1,000 meters, March, 1925 (*Francisco Rivera*); holotype, male.

By Edwards's key to the Philippine species of *Eriocera*,[13] the present species runs to couplet 9, disagreeing with both included species in the slender legs. It closely resembles *E. glabrivittata* sp. nov., differing most conspicuously in the entirely black legs.

TRENTEPOHLIA (MONGOMA) LUZONENSIS Edwards. Plate 1, fig. 13.

Trentepohlia (Mongoma) luzonensis EDWARDS, Notulae Entomologicae 6 (1926) 37–38.

Edwards's unique type, a female, was from Mount Banahao, collected in June, 1914, by Boettcher. I have seen a few additional specimens of both sexes from the same locality, collected above Majayjay, by Mr. A. C. Duyag. The male sex has not been described and is herewith characterized as allotype. The present material is in better preservation than the type and a few additional facts are noted.

Female.—Length, 13 millimeters; wing, 9; fore leg, femur, 12.5; tibia, 16.2; tarsus, about 12.5; hind leg, femur, 13.5; tibia, 14.2; tarsus, about 8.5.

Allotype.—Male. Antennæ with the basal segment dark brown, paler beneath; second segment obscure yellow; basal segment of flagellum yellowish, the outer segments darkened; flagellar segments elongate, without long conspicuous verticils.

Mesonotal præscutum chiefly yellow, the broad lateral margins blackened; a narrower median black vitta begins behind the cephalic margin and ends before the suture, being replaced by a pale yellow vitta that continues backward onto the postnotum; scutal lobes extensively blackened, the median area and scutellum more testaceous yellow. Pleura reddish yellow, the pteropleurite and posterior pleurotergite more blackened. Legs very long and slender, as shown by the above measurements. Wing (fig. 13) whitish hyaline, the costal margin yellow; veins black, C, Sc, and R conspicuously yellow; prearcular veins and the base of cell Cu_1 narrowly yellow; stigma dark brown; very narrow dark seams on m-cu and adjoining portions of vein Cu_1; a dark spot between anal veins near origin. Venation: Rs long and

[13] Loc. cit.

nearly straight; R_{2+3+4} long, gently sinuous; R_2 a little longer than R_{3+4}; tips of R_3 and R_4 pale; proximal end of cell M_3 a little basad of that of cell R_5; apical fusion of Cu_1 and 1st A slight.

Abdominal tergites chiefly dark brown, the outer segments more extensively brownish yellow; terminal segments blackened; sternites more yellowish, the caudal margins of the outer segments blackened.

The middle legs, broken in the type, have the tips of the tibiæ broadly blackened, as in the fore legs.

LUZON, Laguna Province, above Majayjay, Mount Banahao, May 10, 1928 (*A. C. Duyag*); allotype, male, and two additional specimens.

TRENTEPOHLIA (MONGOMA) POLIOCEPHALA sp. nov. Plate 1, fig. 14.

General coloration light yellow; head light gray; legs testaceous yellow, only the terminal tarsal segments slightly darkened; wings subhyaline, veins pale brown; cell 1st M_2 small; inner end of cell M_3 proximad of that of cell 2d M_2; apical fusion of veins Cu_1 and 1st A subequal to m.

Male.—Length, about 4 millimeters; wing, 4.6.

Female.—Length, about 4.8 millimeters; wing, 5.

Rostrum yellow, the palpi very slightly darker. Antennæ relatively long, in male, if bent backward, extending about to the base of the halteres; basal segments yellowish testaceous, the flagellar segments beyond the base dark brown; flagellar segments subcylindrical, gradually decreasing in size outwardly; verticils relatively inconspicuous. Head light gray, the anterior vertex very narrow.

Thorax entirely light yellow, unmarked. Halteres short, pale yellow. Legs with the coxæ and trochanters pale yellow; remainder of legs testaceous yellow, the terminal tarsal segments scarcely darkened; a few conspicuous long black setæ at tips of femora. Wings (fig. 14) subhyaline, the costal region slightly more yellowish; veins pale brown, those of the costal region slightly more yellowish. Venation: Rs a trifle longer than the basal section of R_5; R_2 about one-half its length before the fork of R_{3+4}; cell R_4 large; cell 1st M_2 small, irregularly hexagonal; basal section of M_3 long, arcuated, the inner end of the cell lying proximad of cell 2d M_2; m-cu about two-thirds its length before the fork of M; apical fusion of Cu_1 and 1st A subequal to m.

Abdomen brownish yellow, including the hypopygium, the caudal margins of the segments a little paler.

The allotype female is generally similar to the male, differing as follows: Pleura and abdomen darker, this probably caused by decomposition of tissues within the body; cell 1st M_2 a little more elongate.

LUZON, Laguna Province, above Majayjay, Mount Banahao, altitude over 500 meters, May 26, 1928 (*R. C. McGregor and Francisco Rivera*); holotype, male; allotype, female.

By the author's key to the Philippine species of *Trentepohlia,*[14] *T. poliocephala* runs to couplet 3, differing from both included species in the diagnostic characters as listed. In its pale yellow coloration and small size, the present form agrees with *T.* (*M.*) *flava* (Brunetti), of India. The latter species differs from all known members of the subgenus *Mongoma* in having the distal section of Cu_1 reaching the wing margin and not fused apically with 1st A.

TRENTEPOHLIA (MONGOMA) SAXATILIS sp. nov. Plate 1, fig. 15.

General coloration dark brown, the pleura obscure brownish yellow; legs very long and slender; femora dark brown, the tips abruptly pale yellow; tibiæ and tarsi pale; wings with a faint dusky tinge, cells C and Sc a little darker; vein R_3 conspicuously arcuated, the inner end of the cell being broadly obtuse; cell 1st M_2 relatively short; inner end of cell R_5 proximad of cells 2d M_2 or M_3; apical fusion of veins Cu_1 and 1st A short.

Male.—Length, about 8 millimeters; wing, 8; fore leg, femur, 12; tibia, 15.8; tarsus, about 16; middle leg, femur, 14; tibia, 14.5; tarsus, about 14. Other males show the following measurements: Length, 8 to 9 millimeters; wing, 8 to 9.

Female.—Length, 10 to 11 millimeters; wing, 9 to 10.

Rostrum yellow; maxillary palpi dark brown. Antennæ dark brown. Head dark gray, the vertex with a conspicuous median carina.

Pronotum brown, paler laterally. Mesonotum dark brown, the humeral region of præscutum narrowly yellow; median region of scutum obscure yellow. Pleura obscure brownish yellow, the dorsopleural region dusky. Halteres dark brown, the extreme base of the stem yellow. Legs very long and slender, as shown by the above measurements; coxæ and trochanters yellowish testaceous; femora dark brown, their bases restrictedly pale, their tips abruptly and rather broadly (1.2 millimeters) pale yellow; tibiæ and tarsi dirty white to pale yellow, the tibiæ beyond base very vaguely darkened; no con-

[14] Philip. Journ. Sci. 33 (1927) 302.

spicuous setal adornments on legs. Wings (fig. 15) with a faint dusky tinge, cells C and Sc a little darker; wing apex narrowly darkened; space between branches of Cu darkened; some of the longitudinal veins vaguely seamed with brown; veins dark brown. Venation: R_2 about its own length before the fork of R_{3+4}; R_3 conspicuously arcuated, the inner end of the cell broadly obtuse; cell 1st M_2 relatively short, the veins beyond it correspondingly elongated; inner end of cell R_5 proximad of the other cells beyond cell 1st M_2; inner ends of cells 2d M_2 and M_3 nearly in alignment, subequal; apical fusion of Cu_1 and 1st A short to very short.

Abdominal tergites dark brown; sternites obscure brownish yellow; hypopygium dark.

LUZON, Laguna Province, above Majayjay, Mount Banahao, altitude over 500 meters, May 26 to 29, 1928 (*R. C. McGregor*); holotype, male; allotype, female; paratypes, twelve males and females.

By the author's key to the Philippine species of *Trentepohlia*,[15] the present species runs to *T.* (*M.*) *tenera* (Osten Sacken) in couplet 2. It is a larger species, with very long legs, the femoral tips abruptly pale; vein R_3 arcuated, the inner end of the cell obtuse; inner end of cell R_5 lying proximad of the other cells beyond 1st M_2, and other characters.

The following detailed notes on the occurrence of the species are of unusual interest and value:

"May 28, 1928. On sides of damp rocks, adjoining a small stream. About a dozen, clustered on dark side of a damp rock, just above a mountain stream. They vibrate up and down, as do many other species of this family of flies.

"May 29, 1928. Crane flies on damp, more or less mossy rocks along small forest stream. One, two, or three flies together on vertical or overhanging side of rock, the surface damp and more or less covered with short moss. Water usually directly underneath the flies. The flies are not easily disturbed and can be captured with a wide-mouthed bottle. They never cease their rather fast rocking motion. When disturbed, they fly only a short distance, but take a long time before settling on a rock again. In two cases, only, I saw them hanging from fern leaves, in copulation. I disturbed one pair before I realized the conditions. The second pair I watched for ten minutes, but could not detect much because the upper fly was continually in motion and this moved the lower fly. The larger individual (female) hung with from two to four feet on the pinnæ of a drooping fern frond. The smaller (male) seemed to hang with the legs in the opposite direction."—R. C. MCGREGOR. A sketch from life

[15] Loc. cit.

of this pair shows the female with the front pair of legs holding to two separate fern pinnæ, one additional middle leg similarly holding to a third pinna. The other legs hang free. The small male hung suspended, with all legs hanging free and in the opposite direction from those of his mate. This would seem to indicate that in mating, the genitalia are so twisted that the venter of the male lies on the same side as the dorsum of his mate.

"May 28, 1928. A few, on leaves of shrubs, usually on underside of leaf, one or two of this and related flies [as *Trentepohlia pennipes* Osten Sacken, *T. trentepohllii* Wiedemann, etc.] on a single leaf."—R. C. McGregor and Francisco Rivera.

TRENTEPOHLIA (TRENTEPOHLIA) BAKERI Alexander.

Trentepohlia (*Trentepohlia*) *bakeri* Alexander, Philip. Journ. Sci. 33 (1927) 304–305.

The unique type, a female, was from Mount Maquiling, Luzon, collected by Baker. A considerable series of specimens has recently been sent me by Mr. McGregor, taken at Binauañgan, Obando, Bulacan Province, Luzon, December 29, 1927, where they were found resting on leaves and twigs of mangroves (*R. C. McGregor*). Associated with this species were a lesser number of *Limonia* (*Geranomyia*) *circipunctata* Brunetti.

The present extensive series indicates the following range of characters: Rostrum, in some specimens, much paler than the palpi, obscure yellow. In most specimens, the mesonotal præscutum trivittate with brown, the lateral stripes being well indicated and separate from the median area. Besides the stigmal area, Cu, the cord, fork of R_{3+4} and vein R_5 are distinctly bordered by grayish. Sc_2 usually close to the tip of Sc_1, in some cases at some distance from this tip, Sc_1 alone being approximately one-third the length of Rs.

TRENTEPOHLIA (TRENTEPOHLIA) HOLOXANTHA sp. nov. Plate 1, fig. 16.

General coloration of thorax and abdomen yellow, unmarked; head light gray, carinate; halteres and legs yellow; wings with a yellow suffusion, especially on the costal and apical portions; male hypopygium brownish black.

Male.—Length, about 7 millimeters; wing, 6; middle leg, femur, 10.7; tibia, 11; tarsus, about 6.

Rostrum and palpi brownish yellow. Antennæ obscure brownish yellow, the outer segments of the flagellum somewhat darker. Head light gray, the posterior vertex variegated with darker gray; posterior vertex carinate.

Thorax entirely shiny yellow, without markings. Halteres yellow. Legs yellow, only the four outer tarsal segments black-

ened. Wings (fig. 16) with a yellowish suffusion, the costal region and apex more-saturated yellow; veins yellow. Venation: Sc_2 lacking; R_{1+2} and R_3 likewise very weak and relatively indistinct; Rs relatively short, about two-thirds the basal section of R_5; R_{2+3+4} strongly approaching R_1, R_2 being very short and faintly preserved; beyond R_2, R_{3+4} bends strongly caudad; R_3 oblique; inner end of cell R_5 acute; apical fusion of Cu_1 and 1st A very short.

Abdomen yellow, the hypopygium brownish black.

SIBUYAN, San Fernando, August 9, 1928 (*Francisco Rivera and A. C. Duyag*); holotype, male.

Trentepohlia holoxantha differs strikingly from all described species of the genus in the coloration and venation. The characters of carinate vertex, stout body, and long stout legs are noteworthy in the subgenus.

TEUCHOLABIS (TEUCHOLABIS) CONFLUENTA Alexander. Plate 1, fig. 17.

Teucholabis confluenta ALEXANDER, Philip. Journ. Sci. 27 (1925) 75–76.

The types were from Mount Maquiling, collected by Baker. An additional male was taken by Francisco Rivera, at Mount Irid, Rizal, Luzon, December, 1926. The wing of this species has never been figured and is shown on Plate 1, fig. 17.

CERATOCHEILUS ROMBLONENSIS sp. nov. Plate 1, fig. 18.

General coloration rich brown; pleura yellow with a broad black dorso-longitudinal stripe; legs black; wings subhyaline, cells C and Sc infumed; R_{2+3+4} short, nearly perpendicular; cell M_2 open by the atrophy of m; abdominal tergites dark brown, the caudal margins narrowly pale; sternites obscure yellow.

Female.—Length, excluding rostrum, about 5.5 to 6 millimeters; wing, 4.3 to 4.5; rostrum alone, about 5.8 to 6.

Rostrum (female) approximately as long as the remainder of the body. Antennæ black throughout. Head dark gray, clearer gray on the anterior vertex and posterior orbits. Anterior vertex narrow, slightly less than the diameter of the first scapal segment.

Pronotum black. Mesonotal præscutum rich brown, the lateral margin narrowly pale, scutum brown, the median region more yellowish; scutellum and postnotum darker brown, the latter more pruinose. Pleura pale yellow with a broad dorsal black stripe, extending from the pronotum across the dorsal pleurites and dorsopleural membrane, passing through the root

of the halteres to the abdomen, the ventral margin straight and clearly delimited. Halteres yellow, the knobs dark brown. Legs with the coxæ and trochanters pale yellow; remainder of legs black. Wings (fig. 18) subhyaline, cells C and Sc infumed; veins black. Venation: Sc_1 ending about opposite one-third to one-fourth the length of Rs, Sc_2 some distance from its tip, opposite or shortly before the origin of Rs; R_{2+3+4} nearly perpendicular at origin, cell R_1 at margin narrow; cell M_2 open by atrophy of m; vein M_3 strong, arcuated; vein M_4 weak; m-cu about one-third its length before the fork of M.

Abdominal tergites dark brown, the caudal margins of the outer segments narrowly paler to produce an annulate appearance; sternites obscure yellow; genital shield dark; ovipositor with the valves dark horn color, very long and nearly straight.

TABLAS, Badajoz, August 27, 1928 (*Francisco Rivera and A. C. Duyag*); holotype, female; paratypes, two females.

Ceratocheilus romblonensis differs from all regional species by the open cell M_2. The anterior vertex is narrow, without corniculus.

ILLUSTRATIONS

Plate 1

Fig. 1. *Scamboneura primæva* sp. nov., wing.
2. *Scamboneura psarophanes* Alexander, wing.
3. *Macgregoromyia benguetensis* gen. et sp. nov., wing.
4. *Limonia* (*Libnotes*) *igorota* sp. nov., wing.
5. *Limonia* (*Libnotes*) *banahaoensis* sp. nov., wing.
6. *Limonia* (*Libnotes*) *riverai* sp. nov., wing.
7. *Limonia* (*Libnotes*) *duyagi* sp. nov., wing.
8. *Limonia* (*Limonia*) *imperspicua* sp. nov., wing.
9. *Limonia* (*Euglochina*) *projecta* sp. nov., wing; 9*a*, wing apex, enlarged.
10. *Helius* (*Helius*) *arcuarius* sp. nov., wing.
11. *Lechria luzonica* sp. nov., wing.
12. *Lechria philippinensis* Alexander, wing.
13. *Trentepohlia* (*Mongoma*) *luzonensis* Edwards, wing.
14. *Trentepohlia* (*Mongoma*) *poliocephala* sp. nov., wing.
15. *Trentepohlia* (*Mongoma*) *saxatilis* sp. nov., wing.
16. *Trentepohlia* (*Trentepohlia*) *holoxantha* sp. nov., wing.
17. *Teucholabis* (*Teucholabis*) *confluenta* Alexander, wing.
18. *Ceratocheilus romblonensis* sp. nov., wing.

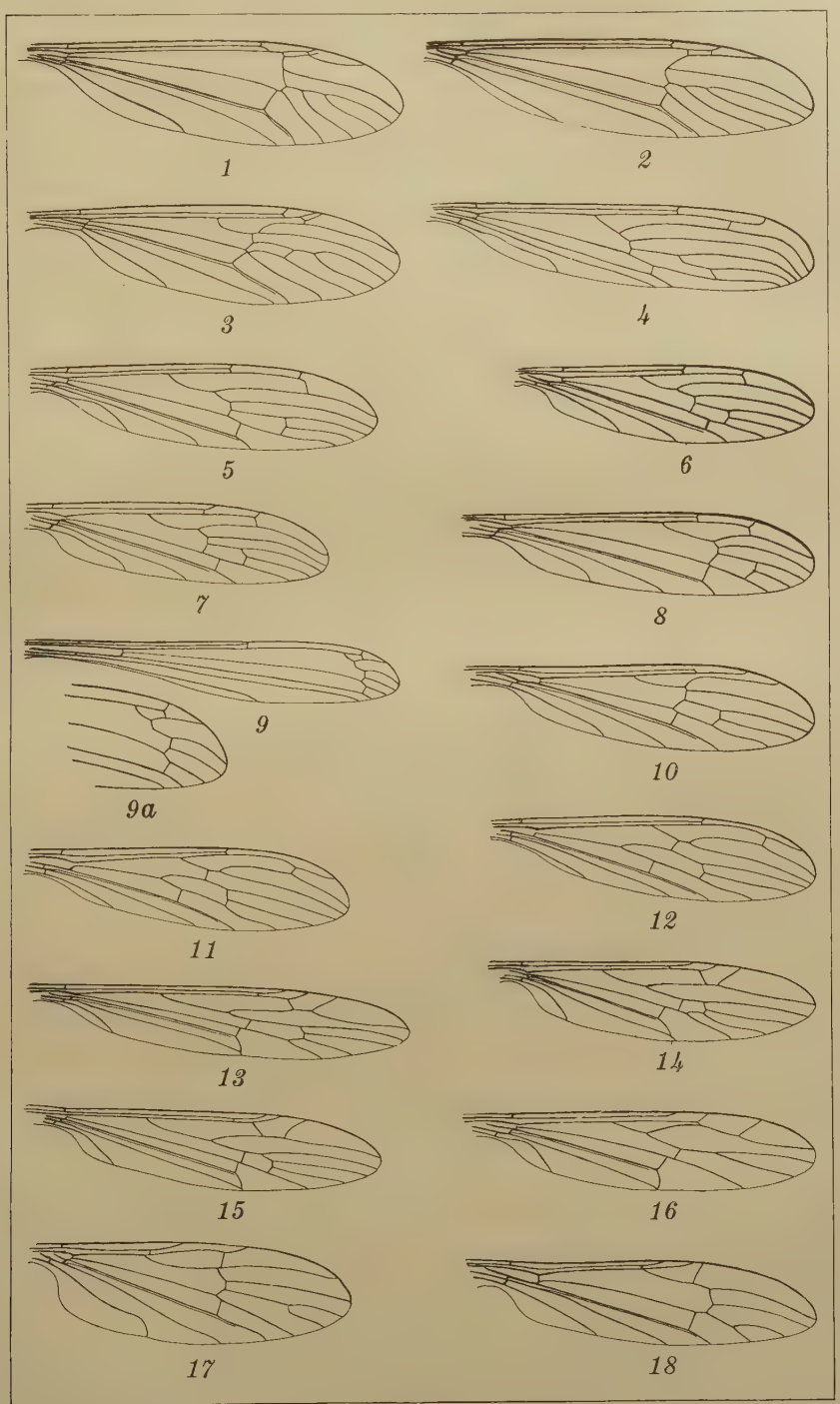

PLATE 1.

COMPOSITION OF PHILIPPINE BAGASSE

By Abelardo Valenzuela and Augustus P. West

Of the Bureau of Science, Manila

During the year 1926-1927, about 4,064,698 tons of sugar cane were ground in the Philippines.[1] Since about 24 per cent of the sugar cane consists of the woody fiber (bagasse), then about 973,500 tons of bagasse were produced. In the Philippines, bagasse is regarded as a waste by-product and is used principally as fuel. Experiments carried out by chemists in the Bureau of Science, Manila, have shown that a good grade of wall board can be made from Philippine bagasse. Researches on Hawaiian bagasse[2] have shown that the bagasse is also useful for making paper. If bagasse could be used for making other commercial products, such as rayon (artificial silk), it would be a very desirable material since large quantities of bagasse are produced annually at the various sugar centrals.

The chemical composition of wood is quite variable and depends upon various factors, such as the kind of wood, age, season, and the location where it is grown. Since wood from different sources shows usually a wide range in composition, it seemed desirable to make a preliminary investigation of Philippine bagasse to determine its various constituents.

EXPERIMENTAL PROCEDURE

The bagasse used in these experiments was made from the Luzon white variety of sugar cane which was obtained from the Calamba Sugar Estate, Laguna, Philippine Islands.

In preparing wood samples for analysis, it is usually customary to get the material in the form of a wood powder fine enough to pass an 80-mesh screen. With the grinding machines at our disposal, we found it difficult to prepare bagasse samples of such a degree of fineness. The method finally adopted was

[1] Compilation of Committee Reports for the Fifth Annual Convention of the Philippine Sugar Association, Manila, 1927.

[2] Little, A. D., Report of the Experiment Station of the Hawaiian Sugar Planters' Association, Bull. 46 (1919).

that of cutting the bagasse into small pieces about 3 millimeters in length, passing the cut material through a grinding machine, and then sieving it.

TABLE 1.—*Fineness of bagasse.*

Mesh.	Bagasse passed. Per cent.
20	61.29
35	33.22
48	3.28

The figures given in Table 1 show the percentage of bagasse which passed screens of different mesh. Only a very small percentage (3.28) of the bagasse passed a 48-mesh screen. This material seemed to be mostly pith and appeared to contain very little fiber. Samples for analysis were selected from the material which passed the 20- and 35-mesh screens. Material passing the 48-mesh screen was discarded.

ANALYSIS

In estimating the principal constituents of Philippine bagasse, in general, the methods given by Schorger [3] were followed. This was especially true for the determination of moisture, cold-water soluble ingredients, hot-water soluble, alkali soluble, ether extract, alcohol extract, ash, nitrogen, pentosans, and copper number. Samples which had passed 20- and 35-mesh screens were used instead of samples which had passed an 80-mesh screen as Schorger recommended. Schorger's method was employed for the determination of alpha cellulose but, as the result appeared to be somewhat high, the Cross and Bevan method [4] was also used. This gave considerably lower results. Probably the correct figures would be somewhere between the results given by these two methods.

There appears to be no accurate method for the determination of lignin. Several methods were tried with indifferent results as shown by the data given in Table 2.

The hydrochloric acid method of Krull [5] and the sulphuric acid method of Mahood and Cable [6] appear to give results which are considerably too high. Moreover, the samples of lignin

[3] The chemistry of Cellulose and Wood (1926) 505–555.

[4] Cross, C. F., and E. J. Bevan, A Text-book of Paper Making (1920) 62.

[5] Schorger, A. W., The Chemistry of Cellulose and Wood (1926) 519.

[6] Mahood, S. A., and D. E. Cable, Journ. Ind. Eng. Chem. 14 (1922) 934.

obtained by these methods did not appear to be of good quality as they were black and charred, and insoluble in acetone. The lignin obtained by the Philipps [7] method was an amorphous brown powder, soluble in acetone. Detailed results of the Philipps method are given in Table 3.

TABLE 2.—*Determination of lignin in bagasse.*

[Figures not calculated on a moisture-free basis.]

Mesh.	Lignin.		
	Method of Krull.	Method of Mahood and Cable.	Method of Philipps.
	Per cent.	*Per cent.*	*Per cent.*
20	30.42	30.68	14.93
35	32.90	31.85	16.45

TABLE 3.—*Determination of lignin in bagasse by the fractional extraction method of Max Philipps.*

[Figures not calculated on a moisture-free basis.]

Mesh.	Fraction.				Total lignin.
	1	2	3	4	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20	7.40	4.26	2.39	0.88	14.93
35	8.06	5.14	2.53	0.72	16.45

These fractions were obtained by extracting the bagasse first with alcohol-benzene solution to eliminate substances such as waxes and resins. The residue was then extracted successively with 2 per cent alcoholic sodium hydroxide (fraction 1), 2 per cent aqueous sodium hydroxide (fraction 2), 2 per cent sodium hydroxide at 135° C. (fraction 3), and 4 per cent aqueous sodium hydroxide at 180° C. (fraction 4). The results show that, by the Philipps method, a 20-mesh sample of Philippine bagasse gave a total of 14.93 per cent lignin, and a 35-mesh sample gave 16.45 per cent. According to this method the total lignin content of Philippine bagasse varies from about 14.93 to 16.45 per cent.

Pectin was determined by the method of Carré and Haynes,[8] which consists in estimating the pectin as calcium pectate.

[7] Philipps, Max, Journ. Am. Chem. Soc. 50 (1928) 1986.

[8] Carré, M. H., and D. M. Haynes, Biochem. Journ. 16 (1922) 63.

The results obtained by analyzing Philippine bagasse according to the methods adopted are given in Table 4.

TABLE 4.—*Analysis of Philippine bagasse.*

[Figures showing the percentage of cellulose, pentosans, lignin, pectin, and ash were calculated on the moisture-free basis.]

	Mesh.	
	20	35
Cellulose:	*Per cent.*	*Per cent.*
(Cross and Bevan)	51.02	48.71
(Schorger)	69.14	63.80
Pentosans	23.13	22.83
Lignin (Philipps)	16.65	18.34
Pectin	1.77	1.83
Ash	3.58	5.85
Ether extract	0.42	0.66
Alcohol extract	2.13	2.00
Cold-water soluble	10.20	11.65
Hot-water soluble	14.93	15.25
Alkali soluble (1 per cent sodium hydroxide)	35.67	36.93
Nitrogen	0.30	0.42
Copper number	8.20	8.70

According to Browne [9] average analyses of purified American bagasse gave 55 per cent cellulose, 24 per cent pentosans, and 15 per cent lignin. These figures compare favorably with the data given in Table 4.

Avram [10] gives figures showing the limit specifications for wood pulp suitable for the viscose-rayon industry. These figures are given in Table 5, together with the corresponding data obtained from the analysis of Philippine bagasse (Table 4).

According to Avram, wood pulp suitable for the viscose-rayon industry should have an alpha-cellulose content of not less than 85 per cent. The ash content should not be more than 0.3 per cent and the copper number not over 3. Our results show that the alpha-cellulose content of bagasse is not over 69.14 per cent, and probably it is considerably less than that. The percentage of ash and the copper number of bagasse are considerably greater than the limit specifications given for viscose-rayon pulp. The data obtained for Philippine bagasse does not meet the specifications of viscose-rayon pulp.

[9] La. Exp. Sta. Bull. 91; Deerr, N., Cane Sugar (1921) 454.
[10] Rayon Industry (1927) 109.

TABLE 5.—*Comparison of viscose-rayon wood-pulp specifications with corresponding data from Philippine bagasse.*

[Figures for the bagasse vary according to the fineness of the material.]

	Viscose rayon specifications.	Bagasse.
	Per cent.	*Per cent.*
Alpha cellulose (minimum)	85.0	48.71–69.14
Ash (maximum)	0.3	3.58– 5.85
Copper number (maximum)	3.0	8.20– 8.70

ALPHA CELLULOSE

Samples of alpha cellulose were prepared from Philippine bagasse. When tested this cellulose showed an ash content of 1.42 per cent and a copper number of 1.14. Although the ash percentage is somewhat higher than the viscose specifications, the copper number is considerably lower. Possibly the alpha cellulose, when isolated from the bagasse, may be suitable for the manufacture of various commercial products. We expect to carry out further experiments with this material.

In Table 6 is given the approximate composition of Philippine bagasse compiled from our analytical data.

TABLE 6.—*Approximate composition of Philippine bagasse.*

Constituent.	Bagasse.	
	20-mesh.	35-mesh.
	Per cent.	*Per cent.*
Moisture	10.33	10.30
Alpha cellulose (Cross and Bevan)	45.75	43.70
Pentosans	20.74	20.48
Lignin (Philipps)	14.93	16.45
Fat and wax (ether-alcohol extract)	2.55	2.66
Ash	3.21	5.25
Other non-nitrogenous substances by difference	2.49	1.16
Total	100.00	100.00

The results (Table 6) show that the bagasse analyzed contains about 16 per cent of lignin. Should lignin become an important commercial substance, bagasse might serve as a possible source of lignin.

NITRATION

Preliminary experiments were carried out on the nitration [11] of Philippine bagasse. The procedure was as follows:

In order to eliminate the fats, waxes, and resins the bagasse was first extracted with a mixture consisting of equal parts of alcohol and ether. The extracted bagasse was boiled in an autoclave with a 20 per cent solution of sodium hydroxide for five hours at a temperature of 160° C. The bagasse was then washed with water to free it from alkali. The moist bagasse was bleached with chlorine gas for half an hour, after which it was boiled with a 2 per cent sodium sulphite solution, washed with hot and then cold water, and dried. The bagasse (20 grams) was nitrated by treating it with a nitrating solution consisting of 87 cubic centimeters of concentrated nitric acid and 137 cubic centimeters of concentrated sulphuric acid. The flask containing the mixture was placed in a thermostat, and the mixture was stirred constantly at a temperature of about 45° C. for seven hours. The bagasse was washed with cold and hot water until free from acids and then dried. The yield of nitrocellulose was about 70 per cent. Analysis by the Kjeldahl method showed that the nitrocellulose contained 3.75 per cent nitrogen.

Similar experiments were carried out on the nitration of alpha cellulose prepared from bagasse. The alpha cellulose was nitrated for five hours at a temperature of 50° C. The yield of nitrocellulose was about 60 per cent, and the nitrogen content was 4.22 per cent. Since mono-nitrocellulose contains 3.8 per cent nitrogen, it would appear that the nitrocellulose preparations made consisted mostly of the mono-nitro derivative of cellulose.

A considerable proportion (about 80 per cent) of the nitrocellulose prepared from bagasse and also from the bagasse alpha cellulose was found to be very soluble in alcohol-ether mixture (1 : 3), acetone, and methyl alcohol. These solutions of the nitrocellulose when poured on glass plates and allowed to evaporate gave a residue somewhat like a transparent film which, when scratched, crumbled to a white powder.

These nitrocellulose preparations of bagasse, when ignited, burned with the quick flashing flame characteristic of nitrocellulose compounds.

Although a number of nitration experiments were performed under different conditions of temperature and concentration of

[11] Lunge, G., Journ. Am. Chem. Soc. 23 (1901) 527.

acids, it has not been possible to make a nitrocellulose containing more than 4.26 per cent nitrogen. The experiments seem to indicate that bagasse and the alpha cellulose prepared from bagasse are not nitrated very readily.

SUMMARY

Samples of Philippine bagasse were analyzed and the approximate composition determined. The results showed that bagasse contains about 45 per cent alpha cellulose (Cross and Bevan), about 20 per cent pentosans, and about 15 per cent lignin (Philipps).

Preliminary experiments were carried out on the nitration of bagasse and on the alpha cellulose prepared from bagasse. Our experiments seem to indicate that bagasse and the alpha cellulose prepared from bagasse are not nitrated very readily since the nitrocellulose we prepared did not contain more than 4.26 per cent nitrogen.

LABORATORY TESTING OF GERMICIDES AND CHEMOTHERAPEUTIC AGENTS

By Otto Schöbl

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When the Philippine Leprosy Research Board was organized by the order of the late Governor-General, Leonard Wood, the part of the program dealing with laboratory investigation of the chemotherapeutic properties of various drugs and chemicals was assigned to me as a member of the board. These investigations were carried out for several years in collaboration with guest workers and members of the staff of the division. Following the footsteps of Walker and Sweeny we tested a long series of vegetable and volatile oils as well as a series of synthetic chemicals and other drugs.[1]

The problem was to establish the fundamental principles underlying the mechanism of the bacteriostatic property of the drugs in question, to study the relation between the structural formula of drugs and their bacteriostatic property in relation to acidfast bacteria, as well as to obtain the necessary information concerning the relative superiority of one chaulmoogra oil or its derivatives over the others. The results of our investigations were a valuable indication to the physician, as to what to expect in the clinic, and were an indispensable guide to the synthetic chemist. A large part of the success in securing new synthetic preparations in the chemotherapy of leprosy was due to the fact that the results of laboratory tests enable the chemist to feel his way more securely and quickly in his search for new and effective compounds.

As a result of laboratory experiments the mechanism of the bacteriostatic action of some vegetable oils was explained. It

[1] Chemotherapeutic experiments with chaulmoogra and allied preparations, I, II, III, IV, V, Philip. Journ. Sci. (December, 1923, to August, 1924). Semiselective antiseptic effect of the vapors of vegetable oils, essential oils, their constituents, and similar compounds, Philip. Journ. Sci. (April, 1925).

was found that the growing acid-fast bacteria saponified the vegetable oil and used only the carbohydrate part of the glycerides as a food and not the fatty acids as was previously claimed. Whether or not the oil will stimulate the growth of acid-fast bacilli, or inhibit it, depends upon the chemical residue of the saponification whether it is antiseptic or inert. It was found by these experiments that hydnocarpic acid is slightly superior to chaulmoogric acid. Independent of our experiments it was found by workers in India that wightiana oil, which has a high content of hydnocarpic acid, is superior to other chaulmoogra oils which have high content of chaulmoogric acid and low content of hydnocarpic acid. The addition of fresh serum to the medication tubes reduces the static effect of sodium salt of chaulmoogric and hydnocarpic acid much more than it lowers that of glycerides or other esters. In the clinic these sodium salts were found not to be superior to chaulmoogra oil, which was to be expected from the laboratory test. The results of tests without the serum showed enormous superiority over the oils and esters with regard to bacteriostatic action. The drop in the bacteriostatic effect of sodium gynocardate, due to the addition of serum, made it clear by simple calculation that impossible quantities of this drug would have to be injected intravenously to bring the concentration of the drug in the body liquids to the point found necessary by laboratory testing for instantaneous inhibition of growth. These laboratory experiments led one to expect little effect from this drug in doses allowed by the toxic limit which again was found by laboratory methods.

Having had these personal experiences and being acquainted with the writings of others who had worked along the same line, I came to the conclusion, as did others, both physicians and chemists, that laboratory tests are of great value to the physician engaged in medical research and that they are a part of the investigation indispensable to the synthethic chemist who is searching for new and more-effective remedies. I was, therefore, greatly impressed by an editorial [2] in which it is stated: "Whatever the final results of laboratory experiments may be reliance should not be placed solely on such results; clinical observations must be considered." The statement appears to insinuate that whenever laboratory methods confirm clinical observations they

[2] The investigation of germicides, Journ. Am. Med. Assoc. 91 No. 10 (September 8, 1928) 728.

are of value, and that whenever they do not they should be disregarded. This attitude seems to slight the value of laboratory investigations. Yet laboratory investigations have been and always will be the only procedure of gaining fundamental information as to new chemotherapeutic drugs. Whenever there is a disagreement between laboratory and clinical findings with regard to chemotherapeutics such disagreement can be explained by no other means than further laboratory investigation. There are many intances in the history of medical research where biologic laboratory investigations revealed information that revolutionized treatment in the clinic or revised and corrected the chemical conception of a drug. The structural formula of atoxyl was accepted and maintained until biologic investigation showed discrepancy between the trypanocidal effect of atoxyl and its structural formula. The formula of atoxyl was revised by further chemical investigation and corrected. This shows the value of biologic laboratory investigation in chemotherapy.

The editorial mentioned above appears to be a critical analysis of the methods employed in testing the comparative germicidal power of mercurochrome-220 soluble and iodine solution in skin disinfection. The editorial leads one to expect the results of such analysis for it says: "It may be well to examine *carefully* the methods used in an attempt to discover the reasons for these discrepancies and to establish the actual clinical value of the germicides in question." One experienced in laboratory investigation has to resort to the papers in question since the alleged discrepancies are, according to the editorial writer, due to differences in technic. There are certain discrepancies in the description of the methods used as given in the original papers and as they are presented in the editorial.

If we analyze the procedures of investigation as given in the publications with which the editorial is concerned we see that Reddish and Drake [3] were primarily interested in their test in the preoperative disinfection of skin. Therefore, staphylococcus, the most resistant of nonsporogenic bacteria, was used exclusively. The tests were restricted to one procedure with one kind of bacteria, the object evidently being to get comparative results of the two drugs concerned, and to obtain information of their relative value in disinfection of skin under usual conditions. In other words only one procedure was used. Simmons [4] on the

[3] Journ. Am. Med. Assoc. 91 No. 10 (September 8, 1928) 712.
[4] Journ. Am. Med. Assoc. 91 No. 10 (September 8, 1928) 704.

other hand included in his test not only staphylococcus, the commonest contaminant of skin likely to infect surgical wounds, but also other bacteria which, though not quite as common as staphylococcus in certain localities and under hospital conditions, are none the less very important; for example, he also included experiments with sporogenic bacteria that are common contaminants of skin around traumatic wounds, which occur on the battlefield and elsewhere. He furthermore performed inoculation experiments to see whether the virulence of the bacteria was impaired or not. Thus Simmons used four procedures while Reddish and Drake used only one of the four used by Simmons. Consequently only part of Simmons experiments are comparable with those of Reddish and Drake. The latter-mentioned authors inserted in their report of their own experiments the clinical opinion of others, thus apparently fulfilling the requirement of the editorial writer. This comment, however, seems to weaken rather than strengthen their argument in favor of mercurochrome and insinuates that their laboratory results were not strong enough to support their claim.

The first of the four procedures used by Simmons was a comparative test of tincture of iodine and mercurochrome in liquid media in which the bacteriostatic effect was checked. The second procedure was the comparative test on agar plates of these two drugs dried on pieces of gauze. The third procedure, which represents experiments on the skin of animals, was an approximation of the conditions existing in the actual use of this germicide in preoperative disinfection of skin. In the last procedure definite areas were contaminated with several kinds of bacteria that represented practically all the groups that enter into the problem of surgical wound infection. After about two hours the skin area was treated with the germicide in question and after definite intervals of time cultures were made on an agar plate and into a 100 cubic centimeter bouillon flask. This done, a second set consisting of agar plate and 100 cubic centimeter bouillon flask were inoculated by washings from a smaller area of the already washed skin. The third set, an agar plate was inoculated with scrapings from the center of the same treated area, therefore from a part of the skin that had been washed twice. The material inoculated was therefore diluted in 100 cubic centimeters of bouillon in Simmons's experiments and in 250 cubic centimeters in experiments of Rodriguez.[5] This is a

[5] Journ. Am. Med. Assoc. 91 No. 10 (September 8, 1928) 708.

far greater dilution than that in experiments of Reddish and Drake who suspended the material examined in 1 cubic centimeter of salt solution and 15 cubic centimeters of agar. Simmons, by successive washings of the treated skin, gradually diluted the germicide. The bacterial content of the surface, as well as of the deep layers of the skin, was investigated at the same time that the actual preoperative conditions were duplicated. Simmons used large amounts of bacteria and considered only striking differences in growth on the surface of plates and in the bouillon flasks. This part of Simmons's experiment is comparable with the experiments of Reddish and Drake, the difference being that Simmons used several kinds of pathogenic microörganisms while Reddish and Drake used only staphylococcus. In this part of the experiments the differences in technic are that Simmons used large amounts of cultures and inoculated plates on the surface, while Reddish and Drake attempted to use a more definite and smaller number of bacteria and poured plates and counted the colonies. This deviation by Reddish and Drake from the technic of Simmons creates at first sight the impresson of greater accuracy. The careful consideration of this procedure discloses that the estimated number of bacteria placed by Reddish and Drake on the area of contaminated skin gives no indication of the actual number of bacteria present on that area of skin at the time of application of the drug, because not only were the animals allowed to move freely in the cage but twenty-four hours expired between the contamination of the skin and the actual testing in some experiments, and the number of bacteria originally placed on the skin could in no way indicate the number of viable bacteria present twenty-four hours later. The counting of the colonies instead of estimating the gross differences of growth also creates an impression of greater accuracy in the work of Reddish and Drake. However, differences of a few colonies were considered as significant, and it was evidently taken for granted that each colony originated from a single bacterium. If one follows the growth of bacteria in hanging drop by Barber's single-cell isolation method one will easily see that the bacteria multiply at an even rate, even conditions being granted, and cling together until the chain or the cluster, as the case may be, of the bacteria reaches large dimensions. Then the groups of bacteria begin to break down into small groups. This, however, does not happen in each hanging drop at the same time. Each separated part of the chain or cluster will give rise to individual colonies. Con-

sequently the same number of bacteria, up to a certain limit, may give rise to 1, 2, 4, 6, or 8 colonies. This period of growth before the periodic breaking down of the large cluster or chains of growing bacteria is responsible for the lag observed when growing cultures are plated at short intervals of time and when the colonies are counted. The apparent refinement therefore of the methods as used in the experiments of Reddish and Drake may give rise to errors. The same can be said about their methods of checking the bacteriostatic action by planting, on the surface of the poured plate, a streak of staphylococcus culture to prove that the germicide in question has been reduced to noninhibiting dilution. When the investigated material is placed in 1 cubic centimeter of liquid on the bottom of the Petri dish, as was done by Reddish and Drake, and the cooled melted agar is poured on top of it, the distribution of the remnants of the germicide will not be even throughout the medium. A thorough shaking in a plate and consequently thorough mixing of the drug with the medium is not guaranteed by such a procedure, because the germicide was placed at the bottom of the plate. The surface of the agar plate is likely to have much less of the germicide than the material in any portion especially the bottom of the agar plate. Moreover, a good many chemicals may become absorbed by the culture medium in twenty-four hours. They may be bound physically to the material under investigation and exert bacteriostatic action on the tested material, but not on the rest of the medium. The solubility in water of the examined drug also comes into play.

It seems superfluous to attempt refining of only one or two out of a number of factors involved in testing a germicide and expect uniform and exact results. In the usual Hygienic Laboratory coefficient method all the important factors are controlled—temperature, the time of exposure, the dilutions, the reaction of the medium, the quantity of inoculum, an a well-known, constantly used culture. Let us neglect one of the factors in this standard method of testing general antiseptics and scrupulously observe the rest of them then surely we shall be disappointed in our expectation of uniform results. Furthermore, in counting deep colonies as done by Reddish and Drake it is difficult to eliminate accidental contamination of the plate, particularly when so common a contaminant of plates as staphylococcus is used. The fallacy of laying stress on differences of a few colonies is evident, because the supposition that one colony results from a single bacterium does not correspond to reality.

We come, therefore, to the conclusion that the experiments of Simmons on the one side and those of Reddish and Drake on the other vary in so much that Reddish and Drake declare the bactericidal action of mercurochrome to be equal to that of tincture of iodine and Simmons finds that tincture of iodine is superior to mercurochrome. Reddish and Drake's conclusion was drawn from their experiments with one type of bacteria. Simmons draws his conclusions and supports them by the results of experiments performed with six representative bacteria; namely, *Staphylococcus aureus, Streptococcus pyogenes, Streptococcus scarlatinæ, Escherichia coli, Clostridium welchii,* and *Bacillus anthracis.* Simmons's contention of the superiority of tincture of iodine is further strengthened by his inoculation experiments which showed that tincture of iodine prevented the death from anthrax of experimental animals, mercurochrome failed to do so. The discrepancies between the conclusions drawn by Simmons and those of Reddish and Drake are due not so much to differences in the technic used as to the fact that Reddish and Drake limited their experiment to one kind of bacteria and to one method of investigation while Simmons attacked the problem from a much broader view. He considered more than one possibility of skin infection and attacked the problem from more than one angle. Hence the differences between the conclusions drawn by Simmons and those arrived at by Reddish and Drake. Which of the two gives more complete evaluation of the drugs in question must be clear to any competent reader.